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Changes and Operating Results at the Coagulation and Sedimentation Plant of the Water-Works of St. Louis, Mo.

By Edward E. Wall*

More than seven years ago the process of clarifying and purifying the water supply of the city of St. Louis by coagulation and continuous sedimentation was inaugurated. Its evolution through the intervening years has been most interesting to those engaged in it, as difficulty after difficulty has been met and more or less successfully overcome. The results to the people of St. Louis have been most gratifying, although they could but imperfectly appreciate the magnitude of the problem, and could realize still less many of the greater and almost all of the smaller blessings which pure water brought to them. To them the greatest boon came from the delight of having an abundance of clear water for the table and the bath, and from the satisfaction of using clean water to make all things clean. The larger benefits arising from its effect on the public health and from its commercial uses passed by almost unnoticed. Today they have almost forgotten that they ever had any other than clear water.

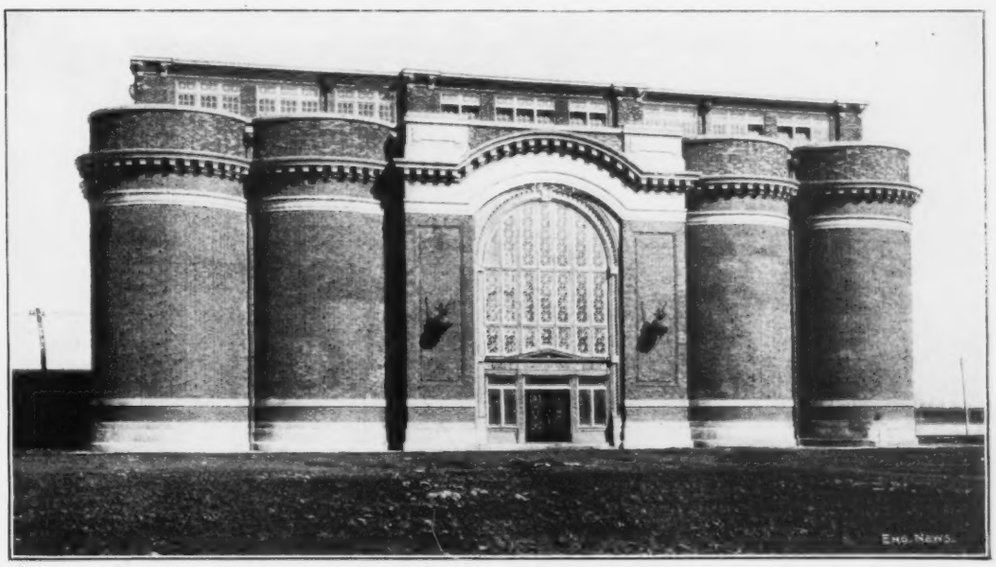
Changes in the Settling Basins

On Nov. 26, 1903, Engineering News published an article [by Mr. Wall] on, "Changes in the Settling Basins and the New Hydraulic Dredge of the St. Louis Water-works," in which proposed changes in the basins were fully described. In order that the reader may see how nearly those plans were carried out, Fig. 1 from that article is herewith reproduced. The differences between the basins as they now exist and as they are shown in Fig. 1 are explained in the subtitle to the illustration.

The present operation is as follows: The river water, charged with coagulants, enters Basin 1 through the four gates, flows through the series of basins from 1 to 6, over the weirs, which are usually submerged, so that the water surface in Basin 6 is practically the same as in Basin 1; thence from Basin 6 to Basin 7 through a 4x8-ft. conduit and on to Basin 8 over the dividing wall. It is then drawn from Basin 8 into the drawing conduit through the gate at the outer corner of the basin. Probably 90% of the sediment falls in Basin 1, necessitating its being cleaned after from four to eight weeks' service, depending upon the muddiness of the river water during the time.

When it becomes necessary to clean Basin 1 the water in the series of Basins 1 to 6 is lowered until the dividing wall between Basins 1 and 2 is exposed. The water is then introduced into Basin 6 from the filling conduit and flows through Basins 5, 4 and 3 into 2, whence it can be drawn directly into the drawing conduit or it may be drawn through the bypass into Basins 7 and 8 as before. Basin 1 is then emptied, cleaned and put in service, the flow from Basin 1 to Basin 8 being through the 84-in. steel-pipe line, and the supply drawn out through the farther gate in Basin 7. When Basin 6 is cleaned the water is drawn down to the level of each weir in Basins 1 to 6, the raw water being again introduced into Basin 1, temporarily throwing Basins 7 and 8 out of service. This is the weak point of the system, and it is now intended to change the basins to get away from the difficulties incident to this condition.

It is proposed to divide Basin 8 into two basins, 8 and 9, each 400x400 ft.; and to extend the inlet from the 84-in. pipe at the outer corner across the basin so as to introduce the coagulated water into Basin 9 in a similar manner to that now used at Basin 1.



West Front of Coagulant Storage and Mixing House for the Water-works of St. Louis, Mo.

(Four large storage bins at either end. Mixing room in center.)

After a basin has been in service a few days, it is the practice to open the sewer gate a short time each day to flush out the sediment, thus increasing the length of time it can be kept in service.

Basin 9 will have two connections to the sewer inside the basin, spaced so that sediment may be washed out from a considerable area. These outlets will be controlled by valves operated from stands above the water, located on steel towers. The wall between Basins 5 and 6 will be raised 2 ft. to avoid the necessity of lowering the water level when Basin 6 has been emptied. The wall between Basins 1 and 2 will be lowered 1 ft., so that the head necessary in Basin 9 to force the flow through Basins 7, 6, 5, 4,

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3, 2 and into 1 may be reduced. When these changes are made, only Basins 1 and 9 will be used for introduction of the coagulated water, thus simplifying the cleaning problem.

During the year 1910-11 there was removed from six basins 161,200 cu.yd. of sediment, at an average cost of 1.62c. per cu.yd., not including the cost of water wasted and used for this purpose. Each cleaning of a basin necessitates the wasting of the water contained therein. This loss in Basin 1 is approximately 30,000,000 gal. at each cleaning; and in Basin 6, 23,000,000 gal. Basin 1 was cleaned three times and Basin 6 twice, making a total waste of 136,000,000 gal. for these basins during the year ending Mar. 31, 1911. Basins 2 and 5 were each cleaned once, increasing the waste to 190,000,000 gal. The cost of this water, which had already received chemical treatment, was $1484. To this must be added the cost of the water used in cleaning, approximately 100,000,000 gal., amounting to $781, bringing the total cost per cu.yd. to 3.03c.

The Hydraulic Dredge Abandoned

The hydraulic dredge described in Engineering News of Nov. 26, 1903, was finally abandoned, after considerable time had been spent in experiment. Results obtained did not seem to warrant the necessary expenditure for perfecting the scheme. The principal objections were the excessive quantity of water wasted in pumping out the sediment, the difficulty of propelling the dredge along the proper lines, the slow progress in getting over the basin, the delays consequent upon imperfect apparatus, the impracticability of providing duplicate pumps to insure continuity of operation, and the fact that experiments seemed to show that the cost of removing sediment would be greater than by the old method of scraping and flushing out the basins by labor and teams.

The Coagulant Plant

An article [also by Mr. Wall] descriptive of the first coagulant plant and of the chemical treatment of the water was published in Engineering News for Oct. 27, 1904. This plant had only been in operation about six months when that article was written, and the writer was a little too optimistic when he said that further steps for improvement must be taken, mainly in reducing the cost of the treatment. He soon discovered many other problems more insistent for solution than that of cost. He has continued to discover them until the present writing, and is not now so ready to devote his entire research to the study of reducing the cost. As a matter of fact, the cost has not been reduced. On the contrary, it has advanced from his figure of that time of $3.20 per million gallons to $4.755 for the year ending April 1, 1911. But to offset this increase in the cost of purification, the quality of the water has been greatly improved and has been maintained throughout the year. The figure of ten parts per million of suspended matter, which was the lowest attained at that time, has been reduced to an average for the year of 2.9, with a maximum of 16. The average bacterial reduction of 88.9% of that time has become 97.6%,

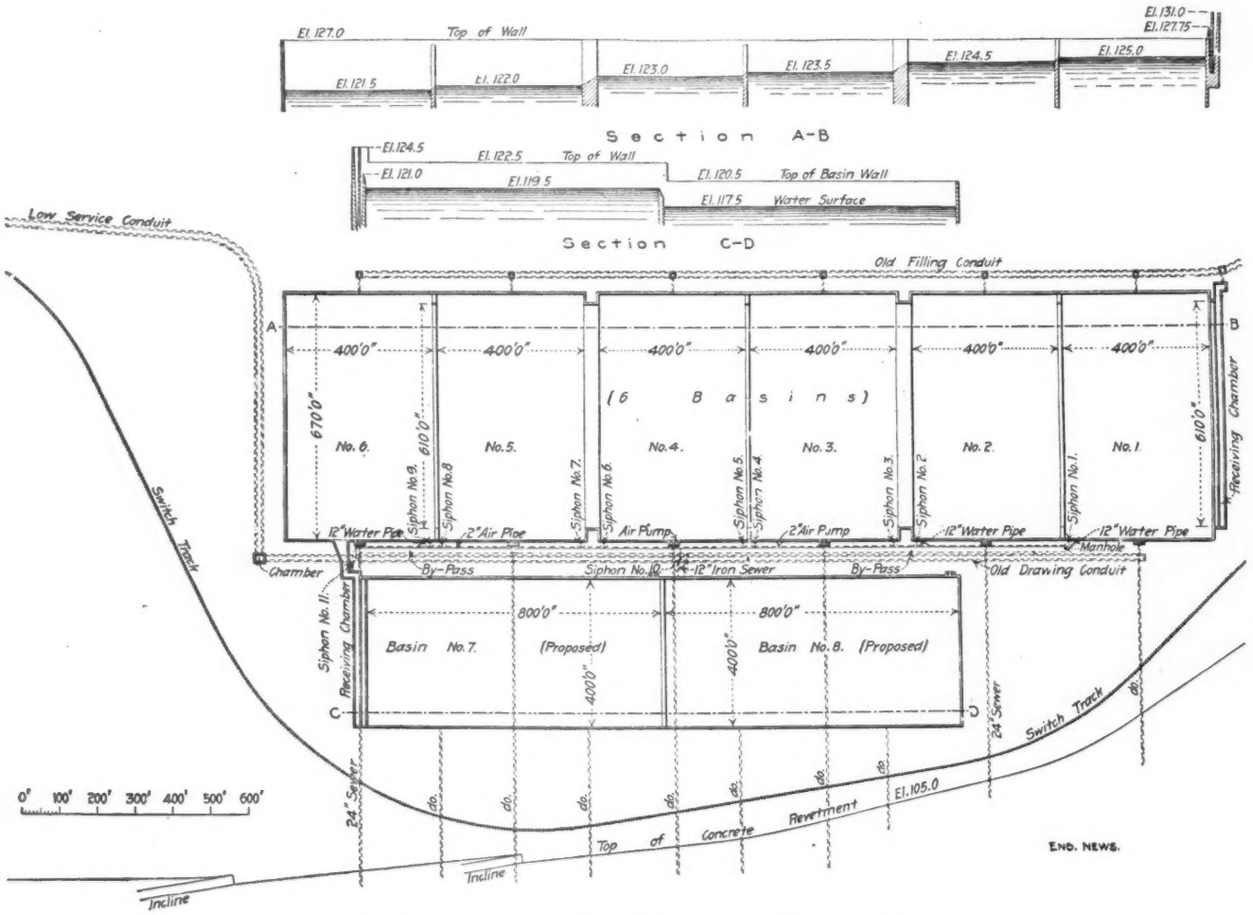

Fig. 1. Original Arrangement Water Settling Basins, St. Louis, Mo.

(Reproduced from Engineering News of Nov. 26, 1903. The differences between the basins as they now exist and as they are shown in Fig. 1 are as follows: Basins 7 and 8 are shifted to the left until the outer end of Basin 7 is on a line with the outer wall of Basin 6. The receiving chamber at Basin 7 was not built, but an 84-in. steel pipe was laid connecting the receiving chamber at Basin 1 with the nearest corner of Basin 8; both Basins 7 and 8 are connected with the old drawing conduit by 84-in. pipe at their opposite ends, and also where they lie adjacent; the receiving chamber at Basin 1 has been covered and four gates, each 3x3 ft., afford outlets from the chamber into Basin 1.)

the average for twelve months ending Mar. 31, 1911.

The temporary plant for storing and mixing chemicals, as described in the article last mentioned, became really an experimental ground for the evolution of the permanent plant, which was later described in ENGINEERING NEWS for Feb. 20, 1908.* For manual labor in handling and transporting the lime and iron sulphate, conveyors and elevators were substituted; automatic scales and feeders, electrically controlled, took the place of platform scales and wheelbarrows; recording thermometers and electric alarms eliminated the dependence on the attendant's fidelity; everything that experience could suggest and that ingenuity could devise was incorporated in the design, yet the plant was not built as described at that time. And when it was put in operation (Mar. 21, 1909) improvements began to suggest themselves before the machinery was well warmed up, and there are still additions and alterations which will be made.

As the plant stands today, the operation may be briefly described as follows: The lime and sulphate of iron are delivered on cars in bulk, and are unloaded into chutes at the sides of the building. These chutes deliver the materials to crushers, whence they are conveyed by scraper conveyors to elevators which discharge them into other conveyors that distribute the lime into the four storage bins at one end of the building, and the sulphate of iron into four storage bins at the other end of the building. These bins are constructed of reinforced concrete, with an inside diameter of 20 ft., and an extreme inside height of 47 ft. The walls are 13 in. thick, the outer 4 in. being brick. The bottoms are hopper-shaped and reinforced to carry a load of 350 tons each. These bins rest on concrete piers which go down to the solid rock about 30 ft. below the ground level. Whenever necessary, concrete beams, heavily reinforced, span the spaces between piers.

A longitudinal section of the building, with a sketch plan broken in on the left, is shown by Fig. 2.

The central portion of the building is given over to the machinery for mixing the solutions. Both the lime and iron sulphate are drawn from the bottom of the bins as the daily use requires, and are again elevated and delivered to steel hoppers, each holding about 30 tons, one of which is located directly above the lime-mixing or slaking tanks, as shown in Fig. 3. These are three circular tanks 7 ft. 6 in. in diameter and 3 ft. 6 in. deep, into which the lime is fed through the automatic scales, of which there are three, one for each tank. Ordinarily one tank is sufficient to slake all the lime necessary, but with very turbid water and heavy pumping two are put in service, there being always one kept in reserve. These tanks are equipped with revolving rakes to keep the milk of lime agitated and to assist in the thorough mixing of the solution and to prevent the settling of the lime. The thorough and continuous hydration of the lime depends upon the temperature of the tank contents being kept close to 200° F., while a constant stream of fresh water is being fed to the tank and an equal amount of milk of lime going out through the overflow pipe.

After long and exhaustive experiments this was found to be attained by keeping the temperature of the fresh water supplied from 90° to 100° F. and adding from 3½ to 4 times as much water as lime by weight. The temperature of the fresh water supply is kept up by passing it through the coils of a heater tank into which the milk of lime at 200° is drawn. There are two of these tanks located on the floor below the mixing tanks. The milk of lime overflows from the heater tanks into a diluting and cooling box, where sufficient cold water is added to bring its temperature down to about 100°, whence it is pumped by a centrifugal pump into the main well, where it is mixed with the water discharged from the main pumping station.

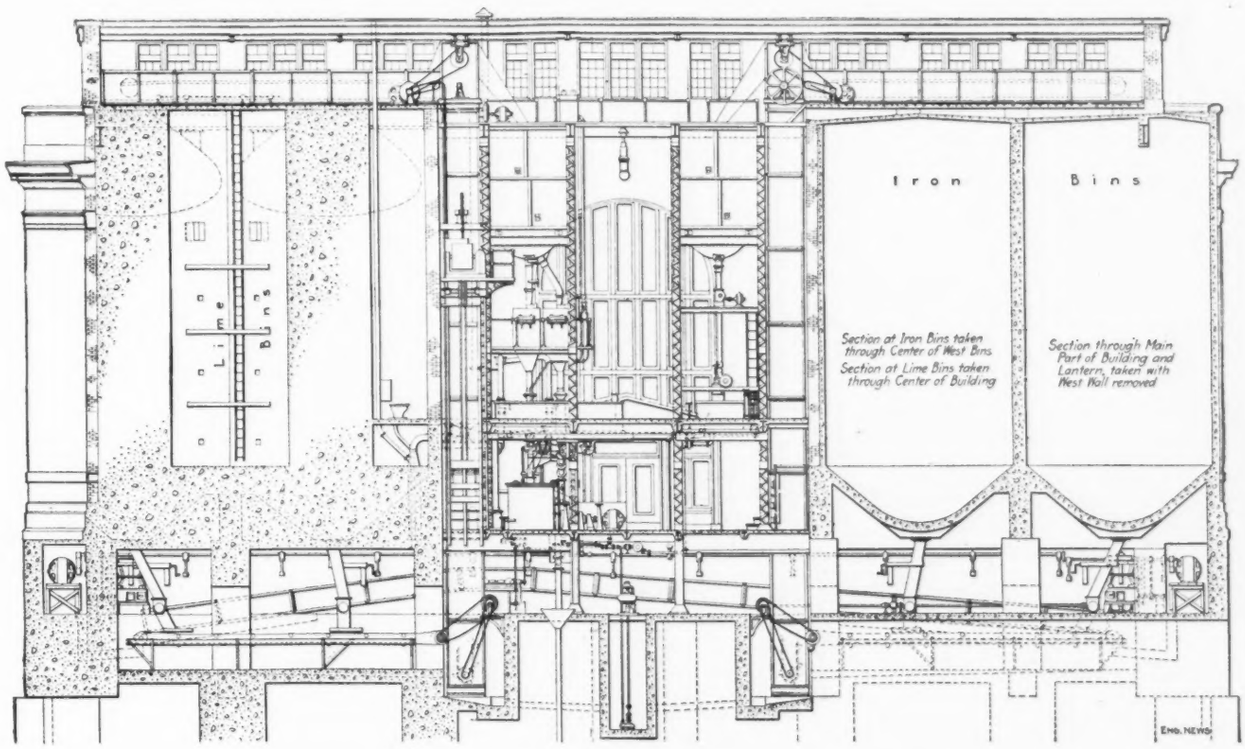
Iron Bins
Lime Bins
Section at Iron Bins taken through Center of West Bins
Section at Lime Bins taken through Center of Building
Section through Main Part of Building and Lantern, taken with West Wall removed
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FIG. 2. LONGITUDINAL SECTION OF COAGULANT HOUSE, ST. LOUIS, MO.

[*Based on a paper prepared by Mr. Wall and presented to the American Society of Civil Engineers. For the complete paper, with discussion, see Trans. Am. Soc. C. E., Vol. LX, pp. 174-216 (1908). The new coagulant plant was also described by Mr. Arthur I. Jacobs, Engineer in Charge of Water-Supply and Purifying Divisions, St. Louis Water-Works, in a paper read before the Engineers' Club of St. Louis, Nov. 20, 1909, and printed (without illustrations) in the Journal of the Association of Engineering Societies for March, 1910.—Ed.]

The automatic scales (between the daily storage hopper and the slaking tanks, Fig. 3) mentioned above can each be adjusted to weigh any amount from 40 to 100 lb. at each operation and to discharge their load at intervals of one minute, two minutes or four minutes, so that by varying both the load and the time of dumping, any amount of lime from 10 lb. to 100 lb. can be supplied every minute. The slaking capacity of the tanks is not much above 60 lb. per min., and the charge is rarely lower than 40 lb. per min., so that the scales are never worked close to their limits. They receive the proper charge and do not discharge their load until tripped by an electric solenoid which is energized by a current turned on by a clock. These scales were especially designed to suit our conditions and were at that time the only automatic scales in existence where the dumping was controlled by a time element.

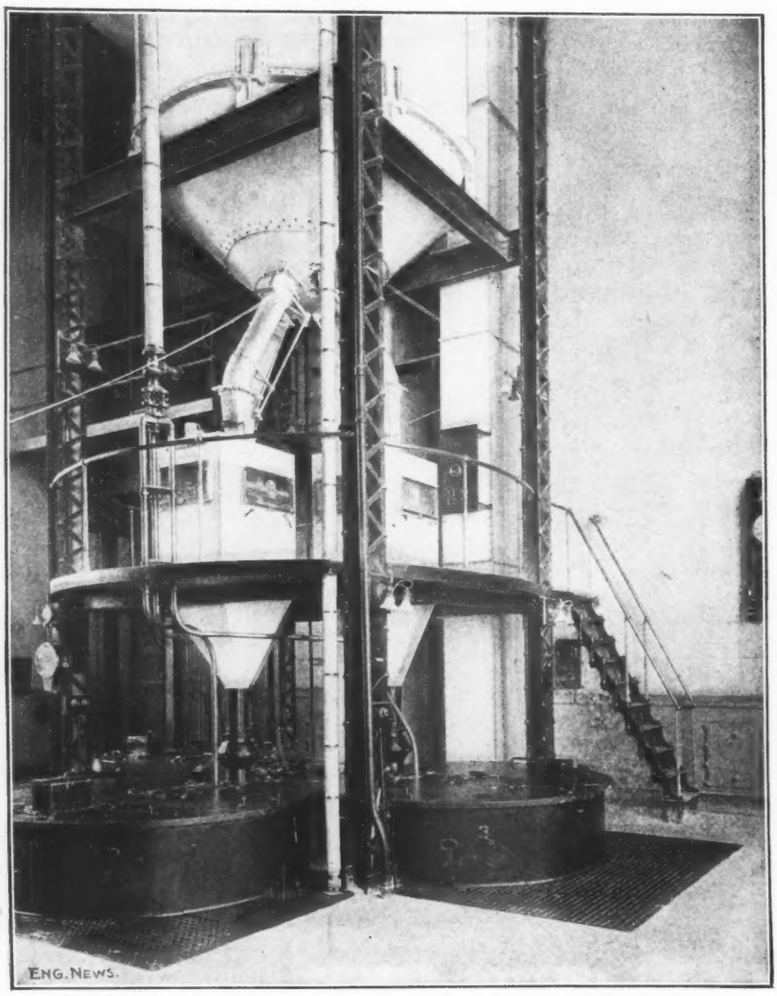

FIG. 3. DAILY SUPPLY LIME HOPPER, AUTOMATIC SCALES AND CLOCKS AND LIME-SLAKING TANKS

The other steel bin is above the two iron solution tanks, as shown in Fig. 4. The sulphate of iron, which, after passing the crusher, is practically free from lumps, and is about the fineness of granulated sugar, is fed into each solution tank through an adjustable orifice onto the surface of a cylindrical drum 12 in. in diameter, with a 5½-in. face, revolving at a constant speed, and is discharged in a continuous flow into the tank. The quantity of iron fed on the surface of the revolving drum is regulated by adjusting the orifice opening. This tank is supplied with fresh water through nozzles in the bottom of the tank and dissolves the iron sulphate, an equal volume of solution passing out the overflow pipe. No agitation other than the motion of the water is necessary for dissolving the sulphate.

The only interesting thing about the iron feeder is the ingenious mechanism for insuring a constant speed to the revolving drum, which is driven by an electric motor. The current supplied to this motor varies in voltage from 480 to 550, thus making a considerable variation in the speed of the motor. The regulator devised to correct this trouble operates by varying the field strength of the motor, cutting out resistance in the field as the speed rises, and *vice versa*. A spring-ball governor keeps an arm poised between two electrical contact points at normal speed, but makes contact above or below as the speed rises or falls. The circuit completed energizes one or the other of two small oscillating solenoids, which in turn throws a dog connected to its plunger into mesh with a ratchet wheel. The latter, keyed directly to the spindle of a rheostat, revolves it either right or left and cuts resistance in or out of the field, as the case may be. The variation in the speed of the drum, as tested on numerous occasions, is less than 0.5 per cent.

The iron solution as it leaves the overflow pipe is conducted through a 3-in. iron pipe into the raw water passing through the tunnel on its way to the main pump. Late experiments indicate that the introduction of the iron solution after the lime is added will produce equally good results with a reduction in the quantities of chemicals necessary to be used. It is probable that the iron solution will be pumped to a point where it will be applied to the water just before it enters the settling basins. It is estimated that an economy of from $15 to $18 per day would result from this change.

The steel hoppers holding the daily supply located above the mixing tanks as described in ENGINEERING NEWS of Feb. 20, 1908, were originally intended to be carried on helical springs so that they would be free to move vertically as the load varied. This vertical movement would have given automatic control of the conveyors supplying them, by switching in the current operating the motors as the hoppers rose when they became nearly empty, or shutting off the current as the load caused them to descend. This end is attained at present by a much simpler device, consisting of a swinging paddle fastened to the top of each hopper. As the material is dropped into the hopper from the conveyor it piles up in a conical shape and, as it rises, pushes the paddle out of the vertical. When the hopper is almost full, the paddle is pushed far enough to one side to break the electrical current and stop the motors. As the material is drawn from the hopper the action is reversed.

From the time that the lime and iron sulphate are unloaded from the cars, the operation of the whole plant is carried on mechanically, and as nearly automatically as possible. The attendants, of whom there are only two on duty at a time, have little to do but see that the machinery is oiled and that all devices are working satisfactorily. Everything, so far as possible, is in duplicate, and is kept in condition for starting up at a moment's notice. Should any accident occur to prevent the operation of the more important machinery for any con-

siderable time, the mixing tanks can be supplied by manual labor.

The duties of setting the scales to weigh the proper amounts, of adjusting the valves to supply the requisite quantity of water to the tanks, of setting the orifice to gage the flow of iron sulphate on the revolving drum, are all mechanical and require no technical knowledge to manipulate. Tables are furnished from which the settings are taken off for any possible conditions of pumping, or changes in the amounts of chemicals, that can arise. Several times each day, as often as the conditions require, samples of water are taken from the basins and from the river. Determinations of alkalinity and turbidity are made from which the chemist makes the changes in the quantities of coagulants to be used.

The total cost of the buildings, machinery, and all changes made in the old settling basins and appurtenances added thereto, for the purpose of the purification process as it was originally conceived to the present day, has been $321,081. This does not include the cost of two reinforced-concrete basins 40x800 ft., each with a working capacity of 45,000,000 gal., which amounted to $525,219, but does include the cost of the original frame coagulant house complete, of all abandoned appliances, of all changes in machinery, and of all experimental work, which last amount is impossible to separate entirely from the total expense. The cost of the present coagulant building, including the machinery, has been $160,060 to date. The original plant cost, when put in operation in 1904, $5900. Changes and additions from time to time brought the total of the old coagulant plant up to $14,225. The receiving chamber and its connections and gates cost approximately $50,000; cutting down the basin walls, about $30,000, the bypass and connections about $60,000, and the 84-in. steel-pipe connecting Basins 1 and 8, $21,000.

For the year ending Mar. 31, 1911, a daily average of 86,646,575 gal. of water was treated by this plant. The maximum for any one day was 125,000,000 gal. on June 11, 1910, the minimum 24,500,000 gal. on Oct. 24, 1910. The highest average for any month was for August, 1910, being 104,000,000 gal.

The pumping for the summer of 1911 was extremely high, the daily average for May having been 103,340,000 gal.; for June, 112,808,000, and for July, 114,888,000 gal. The maximum during these three months was 144,400,000 gal.; the minimum, 63,981,000 gal.

The yearly maximum, minimum and average quantities of chemicals applied in grains per gallon, since the installation of the process, are given in the following table:

TABLE I

	Grains per Gallon					
	Lime			Iron Sulphate		
Year	Maximum	Minimum	Average	Maximum	Minimum	Average
1904–5	9.0	4.0	6.02	5.00	0.0	1.52
1905–6	10.0	5.0	6.28	5.00	0.50	2.20
1906–7	10.5	1.0	7.39	4.75	1.25	2.13
1907–8	9.75	4.0	6.02	4.25	0.0	2.55
1908–9	8.0	4.75	5.58	4.25	1.75	2.41
1909–10	8.25	4.5	5.70	4.50	1.50	2.91
1910–11	7.25	4.0	5.77	4.0	1.75	2.70

Comparing the last year of the old house and the last year of the new, we have the results shown in Table II.

Table III shows the itemized cost of purification per million gallons for the year ending March 31, 1911.

TABLE III

Lime	$1.967
Sulphate of iron	1.969
Unloading	0.094
Labor operating	0.378
Repairs	0.030
Water, coal, oil, etc.	0.047
Light and power	0.098
Chemists	0.172
	$4.755

The cost of operation and maintenance as shown above is somewhat higher than it should be this year, from the fact that there has been trouble and expense in keeping the belt conveyors in order ever since the new house was built. These have been replaced with scraper convey-

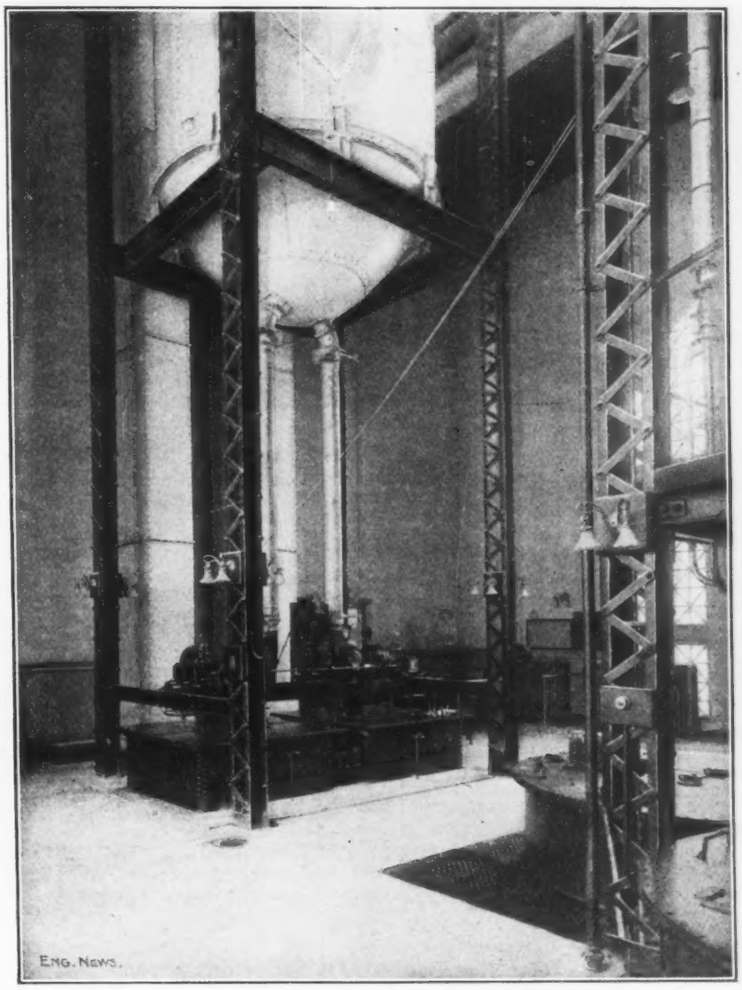

FIG. 4. DAILY SUPPLY SULPHATE OF IRON HOPPER, IRON FEEDER AND IRON SOLUTION TANKS

TABLE II

	Old house	New house	
			June-July,
	1908–09	1910–11	1911
Million gallons water pumped	29,156	31,626	6,461
Cost of coagulation per million gallons	4,546	4,755	5.16
Iron added, tons	5,013.5	6,098	1,642
Lime added, tons	11,611.0	13,032	2,695
Labor operating, maintenance, repairs and material	$13,191.52	$12,884.45	$1,964.10
Unloading lime and iron	3,502.11	2,958.73	595.37
Hot and cold water	1,412.55	1,412.55	236.07
Light and power	2,733.19	3,102.91	472.35
Oil, waste, etc.	95.74	92.95	18.52
Coal and other supplies	89.63	7.55	8.49
Water analysis	5,418.43	5,410.40	1,036.83
Lime	52,830.05	59,294.35	11,281.97
Iron	50,135.00	50,981.18	16,418.08
Switching	2,514.70	3,958.16	1,127.38
Demurrage and car repairs	217.95	237.93	160.36
Total	$132,140.96	$150,370.66	$33,319.52
Total, except lime, iron, switching, etc.	26,443.17	25,891.48	4,523.24
Cost in house per ton material handled	1.65	1.35	1.00

ors, at a cost of about $6400, which, during the few months they have been in operation, have greatly reduced the labor required for cleaning and repairs.

The caking of the sulphate of iron in the storage bins has proved to be a more serious problem than was at first expected. It was believed that by filling and drawing from each of the four bins at short intervals, a sufficient movement of the material would occur so that caking would not take place. What actually happened was that this movement soon came to be confined to a small cylinder of material almost concentric with the bin. This cylinder of loose material could be drawn off, leaving the greater part of the contents standing with only the empty hole in the center. Attempts at dislodging the caked material through bar-holes purposely left in the sides of the bins, resulted in a maximum of labor and a minimum of results. Efforts to use compressed air through long pipes thrust down from the top as well as through the bar-holes loosened the sulphate in the immediate vicinity of the pipe, but raised such a quantity of choking dust that its use was abandoned. A device was recently made in the shops and will shortly be installed which is expected to solve the problem. At the top of each bin a beam almost as long as the inside diameter of the bin will be mounted, so that it can revolve in a horizontal plane about an axis at right angles to its center. At or near each end of the beam is fastened the end of a chain long enough to extend down the sides and across the bottom of the bin, forming a long loop when the bin is empty. This chain will be drawn up out of the way when the bin is being filled and until it is full. After the sulphate becomes caked on the sides and the material can only be drawn from the center as above described, the chain is let down into the opening, and the beam set in motion. The chain dragging around the edge of the hole abrades the material, which drops into the conveyors below, and is taken away to the daily supply hopper. The revolving beam with its chain is driven by an electric motor and will only be used for cleaning out the bin after it has been in service some time, as it takes several weeks for the caking to take place.

The results of the purification process are shown first in the clarifying, which was the prime consideration when the plant was first put in operation, second in the removal of dissolved solids, and third in the reduction of bacteria.

The maximum amount of suspended solids in the river water during the year ending Mar. 31, 1911, was 8008 p.p.m.,* the average for the year being 1297 p.p.m. In the treated water during the same period the maximum, occurring only once and then for one day, was 16 p.p.m., the average for the year being 2.9 p.p.m. In Table IV are the maxima and averages for the river and treated water since 1904.

*Parts per million.

TABLE IV

SUSPENDED SOLIDS

Year ending March 31	River water Maximum	River water Average	Treated water Maximum	Treated water Average
1905	3,763	1,375	97	20
1906	4,067	1,055	162	16
1907	5,031	1,188	27	3.8
1908	6,559	1,237	7.2	1.1
1909	3,800	1,879	27	1.7
1910	6,520	1,542	16	1.1
1911	8,008	1,297	16	2.9

Table V gives the maxima and averages for dissolved solids during the same years.

TABLE V

DISSOLVED SOLIDS

Year ending March 31	River water Maximum	River water Average	Treated water Maximum	Treated water Average
1905	384	256	297	203
1906	345	245	233	169
1907	314	248	263	178
1908	420	274	297	196
1909	435	271	291	195
1910	399	272	245	200
1911	516	315	458	221

The reduction in calcium for the past year was about 52%, of magnesium 25%, while the total hardness was reduced 44%. The alkalinity of the river water was reduced from an average of 161.2 p.p.m. to 49.3 p.p.m. in the treated water. The average color of the water was 21.6, while that of the treated water was 6.06.

The percentage of reduction of bacteria averaged for the year ending Mar. 31, 1911, from the river to the tap was 97.55%. The maximum number of colonies in the river water was 85,000 per c.c.; minimum, 7250. In treated water the maximum was 4700; minimum, 36. The bacteria present in large numbers were principally the common water-borne species, and have no great significance, since fermentation tests with lactose bile in 1 c.c. samples gave positive results in only 69 samples out of a total of 2770 tests of treated water.

Table VI gives the maximum and average number of colonies and average percentage reduction for the past six years.

TABLE VI

Year ending March 31	River water Maximum	River water Average	Treated water Maximum	Treated water Average	Percentage reduction
1906	250,500	66,750	2,500	1,040	97.6
1907	92,500	24,100	7,250	1,350	92.9
1908	362,500	81,370	10,350	1,400	97.2
1909	85,000	22,600	7,500	1,121	96.5
1910	162,500	24,975	3,550	794	97.2
1911	85,000	7,250	4,700	731	97.5

Hypochlorite of lime has been added in more or less of an experimental way during the past year, at such times as there were large increases in number of bacteria, with very encouraging results.

Table VII shows its effects very clearly.

The charge used was approximately 8 lb. per 1,000,000 gal. Permanent installation for applying hypochlorite will be made as soon as some further experiments are concluded.

From the mortality statistics of the city of St. Louis for the ten years past, shown in Table VIII, the writer ventures to draw some conclusions which seem to him to be warranted.

TABLE VII

	No. colonies per c.c. River water	Treated water	
March 29	15,000	300	Hypochlorite treatment begun
30	14,900	101	
31	12,500	34	
April 1	10,500	32	Hypochlorite treatment discontinued
3	21,500	71	
4	15,450	310	
5	30,200	290	
6	39,200	260	
7	26,000	800	
8	29,000	770	
10	25,000	1,050	Hypochlorite treatment resumed
11	25,000	290	
12	25,500	91	
13	11,700	71	
14	17,700	52	

TABLE VIII

Year	Deaths from typhoid	Deaths from all diseases	Population	Death rate per year per 100,000 from Typhoid	Death rate per year per 100,000 from All diseases
1900	168	9,215	575,000	29.22	1,603
1901	198	9,916	586,500	33.76	1,690
1902	222	9,654	598,000	37.12	1,612
1903	287	10,320	609,500	48.09	1,689
1904	225	10,695	621,000	36.23	1,717
1905	126	9,545	632,500	19.92	1,503
1906	112	9,214	644,000	17.40	1,424
1907	102	9,480	655,500	15.56	1,438
1908	95	9,076	667,000	14.24	1,353
1909	101	9,963	678,500	14.88	1,460
1910	95	10,003	690,000	13.77	1,456

In Table VIII figures for population are rather underestimated than too large. The reduction in the typhoid death rate from its maximum figure of 48.1 for 1903, the year immediately preceding the purification of the water, to 13.8 in 1911, should be ascribed entirely to the purification of the water supply, because the conditions affecting that rate were practically unchanged in St. Louis during that period, it being a doubtful question whether or no improvements in general sanitary conditions were keeping pace with the increase in population.

Both the typhoid rate and the general death rate were steadily increasing up to and including the year 1903. The year of the World's Fair at St. Louis, 1904, was one of abnormal conditions and the statistics for that year cannot fairly be used as a basis for calculation.

If we assume that the general death rate of 1689 per 100,000 would not have been decreased in the eight years following had conditions remained the same with the water supply, then the reduction in eight years due to an improved water supply is 233 per 100,000. or a total number of 1607 deaths avoided in 1910.

Allen Hazen, in a paper read before the International Congress in 1904, estimated the reduction in the general death rate due to improved sanitary conditions, when water supplies remain unchanged, to be 20 per 100,000 per year. Allowing the general death rate to be reduced on

these figures there would still have been 338 deaths avoided in St. Louis in the year 1910, entirely due to the improved water supply.

If the same general death rate had prevailed in 1910 as in 1900 there would have been 1014 more deaths than actually occurred. The writer can see no reason why there should have been a lower rate in 1910 than in 1900 had not the water supply been purified, and this saving of life should be mainly credited to that cause.

The economy to the steam user arises mainly from the decreased amount of scale-forming material in solution and from the character of the scale formed. Formerly the muddy water left a soft scale which rapidly increased in thickness, decreased the efficiency of the heating surface and caused the burning out of boiler plates and tubes. The large amounts of suspended matter necessitated continual use of the blow-off.

The treated water gradually forms a hard scale, interfering with the steaming efficiency to a much less degree and requiring cleaning only at much longer intervals. The danger of blistered sheets and tubes is reduced to a minimum.

The reduction in total hardness during the last year from 193 p.p.m. in the river water to 108 p.p.m. in the treated water means a saving in soap to the entire population of over 30%. According to statistics, the daily consumption of soap in large cities is approximately the quantity required to soften one gallon of water per capita. For St. Louis and its water today, this would mean a consumption of over 14,000 lb. per day. Without the softening effected by the treatment the consumption would be over 22,000 lb. per day. With soap valued at 5c. per lb., the saving effected would more than pay the entire cost of purification.

Water Consumption and Waste, the Use of Meters and Meter Rates at Washington, D. C.

Interesting information on water consumption and waste and the use of meters in Washington, D. C., is given in the annual report of the Commissioners of the District of Columbia for the year ending June 30, 1911, recently submitted to Congress.

Water consumption for the year averaged 60,380,000 gal. per day, or an average of 178 gal. per capita per day. The total daily average was slightly in excess of that for the previous year, but less than that for 1908-9 and 1907-8.

The pitometer service detected and stopped a total underground leakage of 6,921,900 gal. per day during the year, over half of which was due to defective service pipes. At the current rate of 4c. per 1000 gal., this waste stoppage saved $101,060, against a cost of only $29,263.

Water meters to the number of 3060 were installed by the water department in private residences during the year, 124 meters were installed by private individuals outside of private residences, and 87 meters were discontinued. The report continues:

The total number of water meters now in use is 18,961. The total number of water services is 62,215. The percentage of water services metered is 29.

The average cost of installing water meters by the District of Columbia during the year was $12.61 each, of which $6 was the cost of the meter and $6.61 the cost of installation. The average annual cost per meter for repairs is 22c. The rate charged for water on metered service is 3c. per 100 cu.ft., with a minimum rate to all consumers of $4.50 per anum. The average annual payment for private residences where meters were installed by the District of Columbia is $4.76. Water rent bills are delivered to householders annually at the minimum rate of $4.50 per annum, which alows the use of 15,000 cu.ft., or 112,200 gal. of water, and if on actual measurement the water is found to have been used in excess of this rate a bill is rendered for such excess.

On the water services which are not metered, water for domestic purposes is charged for according to stories and frontage. For premises of two stories, with a front width of 16 ft., or less, the minimum rate is $4.50 per anum; for each additional front foot or fraction thereof 30c. is charged. For each additional story one-third of the charges as computed above is added. For business premises not metered rates vary from $1 to $25 per annum. Where the rate is $25 or over a meter is required to be installed at the expense of the consumer.

During the year 1972 additional buildings were connected with the public-water system.

It is expected to install 5000 water meters, to be paid for from current revenues, during the fiscal year 1912.

There are at present 45,000 unmetered water services, and the anual increase in the number of new services is estimated to be 3000. The total number of meters estimated to be installed in six years to complete the work of metering, is 63,000. The total estimated cost of the work is $819,000, which will permit the installation of 10,500 meters per year, at an annual cost of installation of $136,500. At the present time only about $65,000 per year can be spared from the water fund for the purpose of installing meters.

The Commissioners believe that the entire water service should be metered within the six-year period above referred to, in order that the necessity for increasing the water supply by the construction of an additional aqueduct, at an estimated cost of about $5,000,000, may be postponed for an indefinite number of years. They have, therefore, by an order dated Sept. 30, 1911, increased the water rates, the new rates to go into effect July 1, 1912.

Under the new rates adopted the minimum payment by meters is increased from $4.50 per year to $5 per year, and the maximum allowance of water for the minimum rate has been decreased from 15,000 cu.ft., or 112,200 gal., to 7500 cu.ft., or 56,100 gal. All water in excess of 7500 cu.ft. is to be paid for at the rate of 4c. per 100 cu.ft., instead of 3c., the present rate.

On unmetered services the flat rate is increased from $4.50 to $5 per annum; which is based on a premises two stories high, with a front width of 16 ft. or less. For each additional front foot or fraction thereof greater than one-half 31c. will be charged, instead of 30c., the prevailing rate. For each additional story, or part thereof, one-third of the charges computed above will be added.

Under the new rates adopted water consumers will continue to receive their water at less than the cost of the service; interest and deterioration, of course, being included.

The new rates will remain less than those prevailing elsewhere.

The above statements indicate that no hardship will be placed upon any consumer.

Indeed, more than one-third of the consumers who now pay the minimum meter rate, to wit, $4.50 per annum, will pay no more under the new rates, inasmuch as they do not now consume up to the new maximum allowed, namely, 7500 cu.ft. Furthermore, after the District is metered the aggregate receipts from the present consumers may be expected to be but little, if at all, greater than they are now.

With the new rates the water department will be placed upon a businesslike basis. The metering can be accomplished in about six years.

If the metering were not done, as proposed, in the immediate future, it would not be too soon now to contemplate the expenditure of millions of dollars for an additional water supply. With the meters installed no further consideration need be given to an increase of supply until the city has grown to twice its present size, for with meters the large periodical humps that occur in the use of water, particularly in cold weather, when consumers now unnecessarily open their fixtures to prevent freezing, may be expected to disappear.

Conservation should be something more than a sentiment, and the metering of the water supply publicly furnished in Washington is a very practical measure of conservation.

It is believed by the water department that the additional revenues due to the increase in rates will be $107,000 in the first year. In the next seven years, however, this increase of the revenues will have gradually diminished to a small sum which cannot be exactly estimated.

If the District of Columbia were to be presented with the meters today, fully equipped and installed, the commissioners would be obliged, nevertheless, to raise the rates, for the reason that with meters and at the present rates the revenues of the water department would fall off from $60,000 to $70,000 per annum, and there would be no money available for putting in the meters in new houses nor for replacing meters that will become worn out.

The revenues of the water department have not been sufficient to take care of deteriorations, in addition to the other obligations placed upon them by law.

In a large section many of the mains are but 4 in. in diameter, and badly choked with mud, the people having been thus supplied as a makeshift measure.

More than a million dollars could with advantage be expended in the near future in replacements.

The report is accompanied by a tabular forecast of receipts and expenses for

the next eight years, to support the statement made in the fourth paragraph from the end of the foregoing quotation. The table is based on the assumption that if 45,000 meters were added at once, and the present meter rates continued, the average yearly payment by each of the 45,000 present flat-rate consumers would be decreased by $1.50 per year, or $67,500. To this loss there would be added the following annual expense per meter: Twenty cents a year for meter reading, 22c. for repairs and 27c. for depreciation, or 69c. in all per meter per year, making a yearly loss and added expense, at present meter rates, of $98,550, and reducing the 1910-11 surplus of $65,550 to a deficit of $33,550.

A note to the table shows that the "surplus" is a mere matter of chance, depending on the amount expended for extensions to the mains. While this may not affect the argument for an increase in rates, it does seem to indicate a need for accounting reform. This need is all the greater, if, as we understand, the water department receives no credit for water supplied for fire protection and other municipal purposes, or if the credit given is based on guesswork, as is so generally the case in American cities where any pretense of such credit is made. We raise these points solely for the purpose of showing that the estimated deficit which would follow the introduction of the universal meter system at Washington, under the present rates, might disappear if the whole system of water charges, public and private, and the system of water-works accounting as well, were put on a modern business-like basis.

The present Commissioners of the District of Columbia are Cuno Rudolph, John A. Johnston and Major Wm. V. Judson. W. A. McFarland is superintendent of the water department.

Removing Pittsburg's Hump

Sketch of a civic improvement which will help to modernize the arrangement of the business district and the transit facilities of Pittsburg. Over two miles of streets in the most heavily-traveled part of the city are to be regraded, with a 16-ft. maximum cut.

After many years of agitation, an important city regrading project, the "Hump Cut" at Pittsburg, Penn., is now to be undertaken. The city council recently made the necessary appropriation for this improvement, on the basis of accurate estimates made for a somewhat more conservative scheme than previously desired.

The "Hump Cut" comprises cutting down about 12,000 lin.ft. of street a maximum depth of 16.3 ft., widening three streets for a total length of over 2000 ft., and opening a short connecting street. All of this work is in a densely built district of high property values, and about half of it is in the district of stores, hotels and office buildings. The problem of distributing damages and benefits was greatly simplified, however, by the fact that a large majority of the owners of affected property gave waivers of damages.

The flat ground of the Pittsburg "Point," in the sharp angle between the Monongahela and Allegheny Rivers, rises abruptly at Smithfield St. to an intermediate level of the high hill territory which forms the interior area of the city. The up-slope east from Smithfield St. to Grant St., 6.7% on Sixth Ave., 7.6% on Fifth Ave., is steep enough to prove very inconvenient to traffic. East of Grant and Ross Sts., however, the ground again drops 10 or 15 ft., i.e., there is a slight "hump," whose summit is a little east of Grant St. The Frick Bldg., a large office structure, and the county court house and jail are on the top of this elevation. That the active business district does not extend east of Grant St., practically, is undoubtedly a direct result of the topographical condition described.

Reduction of street gradients is relatively easy under these conditions. The "Hump Cut" project has accordingly been agitated for many years. Only recently, however, did it make headway against various factors of opposition. The propaganda of the Pittsburg Civic Commission, a private association for promoting Pittsburg's progress, brought it markedly nearer realization. A compendious report on Pittsburg improvements, rendered to the commission by F. L. Olmsted a year ago, contained strong recommendation in favor of the "Hump Cut," and presented specific plans for gradients and depths of cutting. The project as recently adopted by the city council for execution differs only slightly from the plan given in that report.

The map, Fig. 1, herewith, shows the area covered by the "Hump Cut" and indicates the approved depths of cut. The street gradients marked are the new gradients. Comparison with the present conditions is given by the profiles in Fig. 2.

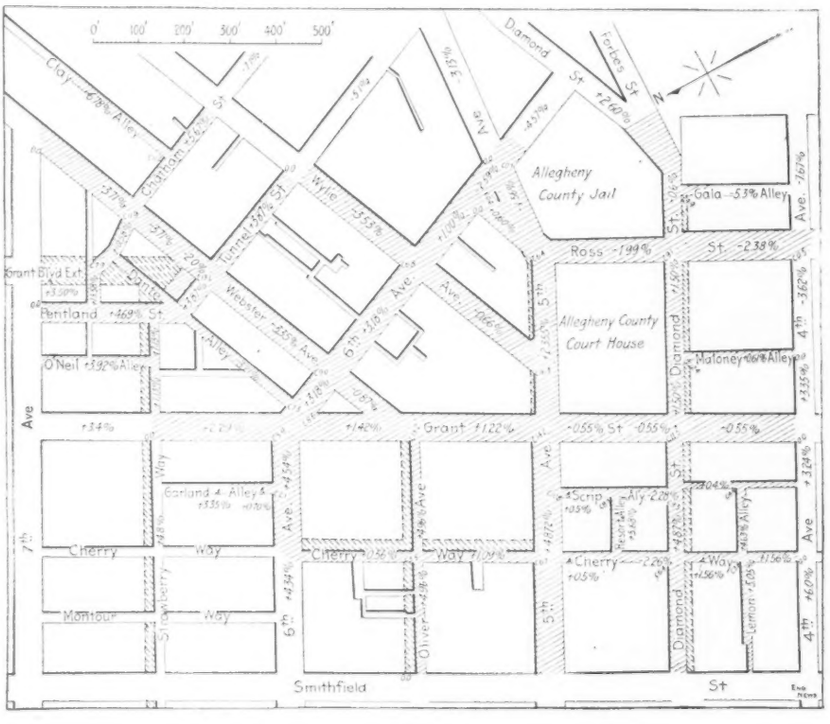

FIG. 1. MAP OF "HUMP CUT," PITTSBURG, PENN.

(From official map prepared by Bureau of Surveys, Department of Public Works of the City of Pittsburg, dated Aug. 11, 1911.)

The benefits of the improvement will lie in its giving the commercial district opportunity to expand eastward in a natural way, and in its facilitating the movement of traffic toward the interior of the city.

An important associated project is the scheme for a new bridge across the Monongahela River on the line of Shingiss St., and in connection therewith a tunnel through the hills of the South Side for direct access to the residential suburbs on the interior slopes. These districts are now reached by surface-car lines passing over the hills, and by one tunnel, near the southern end of the old Smithfield St. bridge. The proposed new route, however, would establish in effect a rapid-transit surface-car route to the southern territory, compared with the slow and congested routes via Smithfield St. bridge.

As may be seen from the map, Fig. 3, where the location of the proposed bridge is indicated, it would connect the center of the city in very direct manner with the South Side suburbs, without increasing the traffic congestion on existing thoroughfares. The project has been quite fully worked out by Hermann Laub. It involves a high-level bridge, of two decks, the upper deck forming the through route to the tunnel, while the lower deck connects the lower river-bank sections. Essentially this project, while it has not yet obtained general public support, is an integral part of the Pittsburg development program of which the "Hump Cut" is the first-executed element.

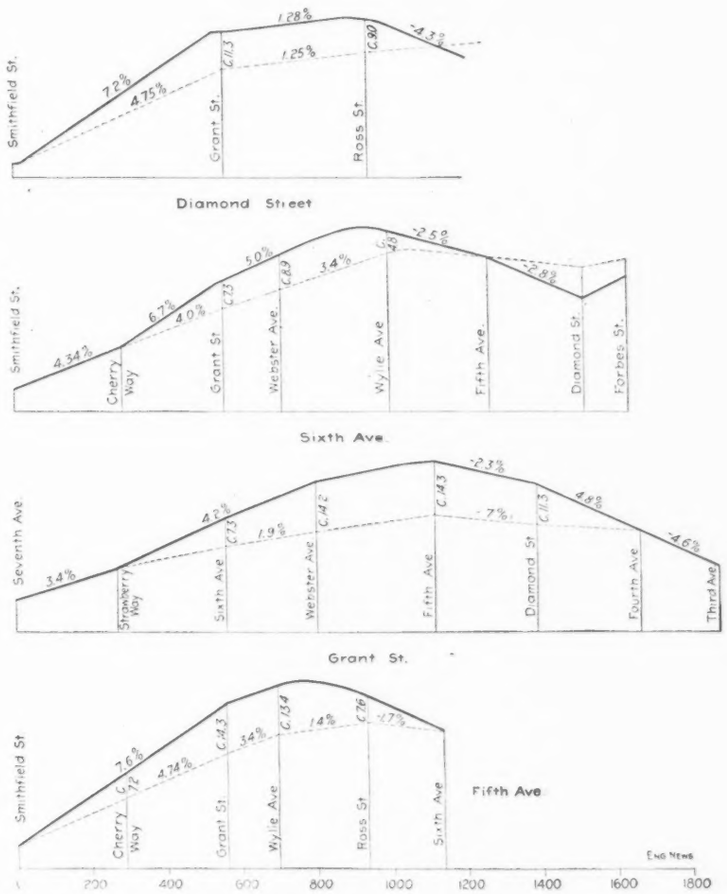

FIG. 2. PROFILES OF FOUR STREETS INVOLVED IN HUMP CUT, SHOWING APPROXIMATE GRADIENTS

(From F. L. Olmsted's report to the Pittsburg Civic Commission, November, 1910. The cuts and gradients differ slightly from those of Fig. 1, which are those of the approved plan.)

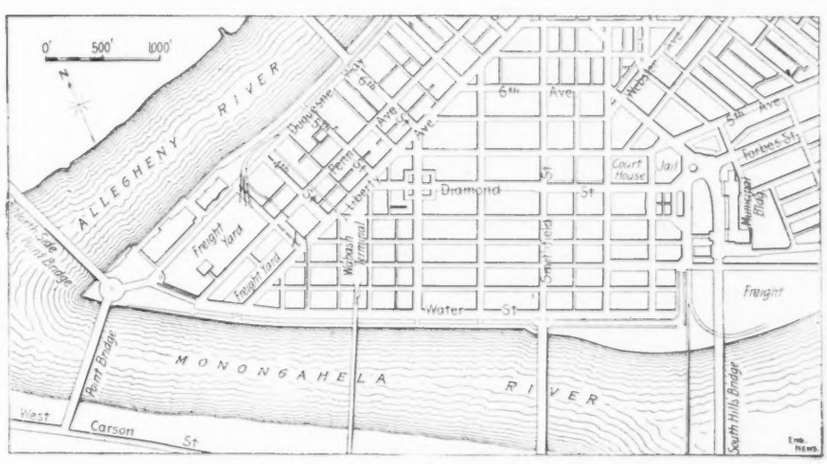

FIG. 3. MAP OF PITTSBURG BUSINESS DISTRICT, SHOWING RELATION OF PROPOSED SOUTH HILLS BRIDGE TO THE HUMP TERRITORY AND THE DOWNTOWN DISTRICT

(After a map in Olmsted's report, intended to show various proposed improvements as though already constructed: South Hills Bridge, new Municipal Building and associated "civic center" improvements, new market, Grant Boulevard extension to Webster Ave., parking along river banks, etc.)

The Manufacture of Brick and Tile in the United States for the year 1909 as determined by the Thirteenth Census, is the subject of a preliminary statement from the Census Bureau. The report shows data for building, fancy, ornamental and vitrified brick, drain tile and all other brickyard products. It also contains a summary of the figures for 1904 and 1909, shown in the accompanying table. Increases are seen in all items for 1909, compared with 1904, except in number of establishments. The Census Bureau and the U. S. Geological Survey coöperated in collecting the figures for 1909, since the Survey collects each year statistics concerning the number of different varieties of brick manufactured. This information for 1909 has already been published by the Survey and has been omitted from the statement of the Census Bureau. The item "Value Added by Manufacture" represents the difference of the cost of raw materials used and value of products after the manufacturing processes have been completed. This figure is considered the best measure which can be made of the relative importance of industries.

SUMMARY OF THE BRICK AND TILE INDUSTRY FOR 1904 AND 1909

	1909	Per Cent. Increase 1904 to 1909
Number of establishments	4,215	—9
Capital	$174,673,000	46
Cost of materials	23,736,000	45
Salaries	5,439,000	54
Wages	37,139,000	30
Miscellaneous expenses	9,431,000	25
Value of products	92,776,000	30
Value added by manufacture	69,040,000	26
Number of officials and clerks	4,951	34
Average number of wage earners	76,528	16
Primary horsepower	341,169	34

A minus sign (—) denotes a decrease.

Railway Smoke Abatement in Chicago*

After years of agitation to compel the railways entering Chicago to electrify their terminals, the business interests and the railway companies have joined hands to secure an impartial technical investigation of the whole matter of smoke prevention.

The Chicago Association of Commerce has organized a Commission to deal with the whole matter and has provided funds to enable the Commission to employ a capable engineering staff for its work.

The preliminary report of the Chief Engineer of the Commission, Mr. Horace G. Burt, former President of the Union Pacific R.R., reviews the history of the smoke-abatement movement in Chicago and describes the various branches of investigation which the Commission's engineers are undertaking.

*Compiled and condensed from a statement prepared under the direction of Horace G. Burt, chief engineer of the Chicago Association of Commerce Committee of Investigation of Smoke Abatement and the Electrification of Railway Terminals. This statement was submitted at the recent annual meeting of the Chicago Association of Commerce.

The general history of smoke abatement in Chicago, keeping especially in view the part of the railways therein, naturally subdivides into three periods: (1) The period of the ordinance of 1881, this comprises smoke abatement as a branch of the City Health Department's activities; (2) the ordinances of 1903 and 1905, smoke abatement as included in the work of the Steam-Boiler Inspection Department; (3) the ordinance of 1907, smoke abatement as constituting an independent department.

Smoke abatement first took tangible shape in Chicago about the year 1881. The immediate but not the sole occasion of the first action taken appears to have been the notion that, with proper effort, locomotive smoke might be abated on the railways in Chicago as it had been abated (so it was claimed) on the Old Colony R.R. (Massachusetts). In 1881 a smoke-abatement ordinance was passed affecting the railways along with other classes of smoke makers. Although railway managers were then inclined to regard the abatement of railway smoke as rather impracticable, the railways as much as other smoke makers made real efforts in abatement, and admittedly so, as frequently appears in the reports of the City Smoke Department. Some roads, at least, had their own smoke inspectors and made use of smoke-abating devices.

This was especially true in the years immediately preceding and succeeding the World's Fair, as well as during the Fair (1893). That there were peculiar difficulties in successful smoke abatement on locomotives was felt by the railways, and was recognized by the City Smoke Department. That some progress was made in overcoming these was also recognized. When the less difficult problem of smoke abatement among stationary plants in the city seemed to be solved or to be approaching solution, the railways were considered by the City Smoke Department as still on probation, as it were.

The City Smoke Department's report for 1910, which covered practically the entire period that elapsed between the passage of the ordinance of 1907 up to the close of the year 1910 suggested, or, rather, frankly declared, the necessity of a radical change in the existing conditions of smoke abatement so far as the railways were concerned. In fact, it recommended in explicit form the electrification of railway terminals within the city as something necessary to the desired progress in smoke abatement.* A like conclusion had already been advanced by others. The matter of electrification as one virtually involved with the commercial interests of the city as with those of the railways had, in fact, become one of serious consideration on the part of the Chicago Association of Commerce, of the railways and of the city administration.

Investigations as to Smoke Abatement and Electrification

As early as 1908, or earlier, the mayor appointed a committee to investigate and report; and in the year named was issued an extended report, prepared under the auspices of the mayor and the Committee on Local Transportation of the City Council. This report, in effect, recommended an immediate electrification of railway terminals in Chicago.† In October, 1909, a committee of experts appointed by the Chicago Association of Commerce reported favorably for electrification as a mechanical problem, but was less confident as to the financial feasibility of it. In a discussion of the committee's report it was suggested that the matter was one for coöperative effort, and it was proposed to get in touch with the city administration. This was to be done through the mayor, who would be requested to delegate suitable persons to act, in conjunction with others appointed by the Chicago Association of Commerce, as a committee of investigation. It was understood that the railways would provide the funds for the promotion of the investigation.

At a meeting of the association held in September, 1910, representatives of a dozen leading railways canvassed the matter of electrification. The sentiments expressed pointed to the following conclusions, among others: (1) The electrification of railway terminals would involve an enormous expense, which would have to be borne by the commerce of the city; (2) immediate electrification would be premature; (3) smoke abatement need not depend wholly upon electrification. The subject having thus been brought home to all concerned, the time was ripe for a coöperative handling of it.

At a meeting of the Chicago Association of Commerce on Mar. 18, 1911, its standing Committee on Electrification took preparatory steps toward a proposed new investigation of the subjects of smoke abatement and electrification of railway terminals in Chicago. President Wheeler announced the names of a number of gentlemen who, together with others appointed by the mayor, should form the general committee of investigation. The members of the committee as thus constituted were: Paul P. Bird, T. E. Donnelley, W. A. Evans, Milton J. Foreman, Wm. A. Gardner, W. F. M. Goss, E. R. Graham, Richard C. Hall, H. G. Hetzler, Jesse Holdom, Darius Miller, Frederick H. Rawson, Harrison B. Riley, C. E. Schaff, John W. Scott, Francis T. Simmons, Mason B. Starring, Harry A. Wheeler. The first four named were appointed by the mayor.

At a meeting on April 1, a sub-committee recommended that the investigation should include the following heads: (1) The necessity of any proposed change; (2) the mechanical practicability of any such change; (3) the commercial feasibility thereof.

On April 14, Horace G. Burt was appointed chief engineer, and engineering assistants were selected by him later as follows: Electrical engineer, Hugh Pattison; terminal engineer, L. H. Evans; mechanical engineer, T. H. Curtis; assistant engineer, James Walker; consulting electrical engineers, Gibbs & Hill, New York; consulting mechanical engineer, George R. Henderson, Philadelphia.

*The same view was expressed in a paper read before the Western Society of Engineers (Chicago), by Paul P. Bird, chief smoke inspector. This paper, with an editorial comment on the subject, was published in our issue of Mar. 2, 1911. See also Engineering News, June 18, 1908.—Ed.

†An editorial discussion of the ordinance intended to force electric traction for the terminal lines of Chicago railways was published in our issue of Oct. 7, 1909.—Ed.

Six meetings of advisory committees to the general Committee on Smoke Abatement and Electrification have been held. At these meetings discussions have occurred of topics of leading importance. A brief account of the meetings and discussions will be a matter of some interest.

Devices and Methods for Abating Smoke from Locomotives

In response to a call issued by the chief engineer, a meeting of the advisory committee consisting of motive power and mechanical representatives of railways operating in Chicago was held August 15. With the call of the meeting were issued, for the information and consideration of those concerned, forms for reporting locomotives operating within the city limits of Chicago, and locomotives operating within the city limits which are equipped with smoke-abating devices.

In a general discussion which occurred among the representatives of the various roads, the following named subjects were treated: (1) Brick arches as locomotive smoke-abating devices; (2) ordinary and special stack blowers; (3) steam jets; (4) mechanical stokers; (5) the use of coal; (6) different fuels used in different classes of service; (7) the education of firemen. The discussions (which continued through the greater part of the day) served to open up the general subject of smoke-abating devices and to map out the work for further investigation. On some of the individual topics special discussions have already been held.

A brief outline of views advanced in the first discussion may well be given. On the subject of coke and its use on locomotives, a definite conclusion was reached with little difficulty, and it was decided to eliminate coke entirely from further consideration. Of particular interest was the discussion on brick arches. The view was expressed that the brick arch was of value as an aid to combustion and smoke prevention, especially on locomotives engaged in continuous service. As regards its value on locomotives in intermittent service, a difference of opinion developed. The subject was referred to a special committee, to which the subject of stack blowers was also assigned. The education of enginemen as to the proper method of firing, with a view to smoke prevention, was emphasized by a pretty general unanimity in the meeting.

At a meeting (Aug. 28) of the special committee appointed to consider the brick arch and stack-blower, a resolution was adopted recommending those devices as useful within certain limitations. The subject of brick arches again came up for discussion at a meeting (Nov. 2) of the advisory committee of motive-power and mechanical representatives of railways. The previous discussions of the subject were reviewed and it was decided to continue the special committee on this important subject. Other important topics handled at this meeting were the down-draft furnace, steam jets, and the Crawford automatic underfeed stoker for locomotives.*

On the subject of the down-draft furnace, a diversity of understanding and opinion prevailed, and a desire was expressed for a further opportunity of investigation. Mr. Crawford, of the Pennsylvania Lines, volunteered to equip for the purposes of experimentation one of the locomotives under his charge with a down-draft arrangement. There the matter rests for the present. On the subject of steam jets, Mr. Curtis, mechanical engineer of the staff, explained at some length a memorandum prepared by him from reports made by various railways as to the respective practices pursued by them with regard to steam jets. There was also discussion of the matter by various railway representatives. A final decision on the subject was not reached.

At the close of the meeting, Mr. Crawford offered an explanation regarding the use of his automatic stoker, and announced an exhibition of the same to occur at the close of the session. The exhibition was witnessed by members of the engineering staff and was regarded as satisfactory as a trial exhibition.

Determination of Smoke and Its Sources

The character, amount and distribution of the ingredients of smoke in general would depend upon the character, amount and distribution of the various kinds of coal burned respectively by stationary plants (including domestic fires) and by locomotives and boats in the various districts of the territory under investigation during the given period. While the total amount of coal consumed might be ascertained with reasonable accuracy, the determination of its distribution among the various classes of consumers would be a matter of considerable difficulty.† In determining the character of the visible smoke emitted from the various sources, it is proposed to employ the Ringelmann chart as far as the smoke of stationary plants, railways and boats is concerned.

As to cinders and dirt (soot), tests have been made with regard to locomotives, but not with regard to boats and stationary plants. The proportion of cinders and dirt (soot) from boats could be estimated nearly enough for practical purposes. In the case of stationary plants, some original experiments will be necessary. These could probably be arranged with some of the industrial manufacturing plants and with some of the railway stationary plants. Owing to the lighter character of the cinders and dirt (soot) from stationary stacks and to the greater height of such stacks the investigation of them would be a matter of special difficulty. The character and amount of gases arising from the various sources under consideration have been pretty fully determined by special tests. But the distribution of them as between stationary plants and locomotives cannot easily be made with any degree of accuracy.‡

Various methods, and various scales of measurement, have been in use in the measurement of smoke throughout the world. The Ringelmann chart has been in quite general and authoritative use so far as visible smoke is concerned. It is proposed to adapt this scheme more closely to actual conditions than has been done hitherto, by making a classification of the stacks with reference to sizes and other matters affecting the visible character of smoke. The scheme involves a scale of five degrees of density as follows: (1) Light gray smoke, (2) darker gray smoke, (3) very dark gray smoke, (4) black smoke, (5) very black smoke. "No smoke" is indicated by zero. "Dense smoke," according to general use, denotes either or all of degrees (3), (4) and (5). With different classes of stacks given, these degrees would receive different values.

On the closely allied subjects of combustion and its kinds, smoke and its production, its constituents and its measurements, a conference was held Sept. 12. After a general explanation of the nature of combustion and a brief historical review of the designations applied to smoke considered as a nuisance, and of the aspects under which smoke has been regarded throughout the world, there was an earnest general discussion on the methods of smoke measurement. The Ringelmann scheme for estimating smoke density was carefully canvassed and was recommended by the advisory committee as applicable, so far as visible smoke is concerned. The sanitary view of smoke was also clearly presented and attention was directed to certain aspects of smoke to which the Ringelmann scheme was not considered applicable.

As a general result of the discussion, it was recommended by the advisory committee that smoke be studied under the three aspects of (1) visible smoke, (2) cinders and dirt, (3) gases. A resolution was passed embodying the above indicated recommendation regarding the Ringelmann scheme of smoke observation. It was clearly understood throughout the discussion that the determina-

*Engineering News, Apr. 13, 1911.

†An estimate of this distribution was made by Paul P. Bird, smoke inspector, in the paper printed in our issue of Mar. 2, 1911, but the estimate is regarded as of doubtful value.—Ed.

‡A paper on "The Problem of Smoke Reduction on Railways," by A. W. Gibbs, was published in our issue of Apr. 22, 1909.—Ed.

tions of the meeting were to be accepted by the engineers' staff as tentative suggestions rather than as absolute dicta.

Coal Consumption in Relation to Smoke

The subject of coal consumption within the Chicago switching district was discussed at a meeting of the advisory committee held Nov. 3. The discussion was conducted with the view of determining ways and means of ascertaining the amount and distribution of coal consumed within the Chicago switching district. A principal object was to learn (by applying the information gained as to the coal consumers) who and in what proportions the smoke producers of the district under investigation might be.

The discussion elicited, as a provisional division, the separation of the total coal consumed into railway coal, steamboat coal and commercial coal. It was agreed that the railways were or could place themselves in a position to report accurately as to the coal consumed by them; and different views as to the means of doing so were presented and discussed. For final determination the subject was handed over to a special committele. Discussion also took place as to the distribution of commercial coal, and the part which the railways might have as to that; but plans as to the complete determination of the matter remain to be fully and finally settled. Nothing particular was determined as to steamboat-coal consumption, which will doubtless form a subject of future consideration.

Results of the Investigation

A summary statement may be offered, as follows: The investigation up to the present time has been chiefly occupied, as seemed natural and necessary, with the subject of locomotive smoke abatement. Nevertheless, the subject of the electrification of terminals has been kept well in view and a beginning made in the consideration of it. Much time and attention have been given to developing the means of collecting data and information as to present physical and operating conditions. It is expected that in the course of the next few months, tangible developments will appear in the handling of the matter of electrification.

Of necessity the investigation has thus far been occupied with beginnings and not with results. In proportion as it has progressed, the problems presenting themselves for solution have rather increased than diminished in number; and it is sufficiently clear even at the present stage that for the accomplishment of definite and valuable results much labor and considerable time will be required.

Features of Electric Furnace Design*

By Carl Hering†

The wide application of electric furnaces is an economic question, and before a final answer is given the furnaces must be designed for minimum losses.

The chief loss is by heat conduction through the electrodes. If large and good conductors they have a small resistance loss, but chill the furnace by conducting out a large amount of heat from the charge. Small and poor conductors develop much heat from the large currents which are transmitted. The total loss through electrodes is a minimum when the heat generated in them by the current is sufficient to raise the inner end to furnace temperature.

Up to a certain point, the heat conduction through furnace walls is rapidly reduced by increasing the thickness. Soon the reduction of loss by further increase of thickness is so small that the saving fails to justify the cost.

As it is such a simple matter to convert electric energy into heat, electric furnaces have, to a large extent, been designed and constructed by metallurgists and chemists rather than by engineers; almost any crude electric contrivance will produce heat, and hence was good enough; the main question was: Will it perform the necessary metallurgical, physical, or chemical reactions? Now that the latter has been demonstrated beyond question for a large variety of processes, the inevitable question naturally arises, "Will it pay" to use electric heat? To determine this it becomes necessary to design and construct the furnaces to reduce the inevitable heat losses to the least possible. This is of far greater importance for electric furnaces than for those using the combustion of fuel, as the cost of a heat unit is considerably greater when produced electrically than when generated directly by combustion. Fuel furnaces are, as a rule, so very wasteful that their design is of little or no aid in designing electric furnaces.

The purpose of this present paper is to point out and discuss briefly some of these engineering features which are involved in the design and construction of electric furnaces, with a view to perfecting them as engineering structures.

Before doing so, however, it may be well to dispel the prevalent idea that the electric furnace is still only a laboratory device or a mere fad. It is true that it is not as commonly seen as many other electric devices, and that, being generally an inclosed structure, the operation in its interior is not generally appreciated by the layman, but statistics show that there are hundreds of large furnaces in daily use, and that they produce thousands of tons of products daily. Some of them produce well known products cheaper or better than fuel furnaces do, while in others products are made which were never known before, or which could not be produced commercially in other furnaces. Among the former may be mentioned aluminum, steel, iron alloys, bisulphide of carbon, phosphorus, etc.; among the latter, carborundum, calcium carbide, artificial graphite, silicon, nitric oxides, etc. Some of the industries developed by the electric furnace even promise to affect the wealth of nations.

It requires no skill to convert electric energy into heat; nature will do this for us and, unlike as in other conversions, it does it virtually at a 100% efficiency. As a converter of energy the electric furnace is the simplest kind of an apparatus; it is doubtless for this reason that its early development was in the hands of others than engineers. Every arc light, for instance, is a small high-temperature electric furnace, and to get more heat the arc was simply made larger (by increasing the current, not its length) or several arcs were used. As an electric furnace is, or should be, inclosed, the radiation and convection losses are reduced to the least possible, leaving as the chief loss that of conduction through the walls and the electrodes which must necessarily pass through them. The latter, therefore, constitutes the chief problem for the engineer.

Conduction of heat through solid bodies may be said to be a true flow of energy. This flow may in many of its features be likened to a flow of electricity through an electric conductor, except that

*From a paper before the Philadelphia Engineers Club, printed in the October Proceedings.

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the flow of heat is very slow, while that of electricity is practically instantaneous. It is also like a flow of water through a porous material. Quantitatively, the flow in heat units per second is directly proportioned to that which causes it, namely, the difference of temperature; and inversely to that which opposes it, namely, the thermal resistance of the body, which is the reciprocal of what is generally termed the conductivity (more correctly, the conductance) of the body. Hence the quantitative law is exactly like Ohm's fundamental law of electric current.

The study of such flows of heat through bodies does not seem to have been given the attention which it deserves; it applies also to other branches of engineering, such as refrigeration, the heat insulation of engine cylinders and steam pipes, the transmission of heat from the hot gases in a boiler to the water, the construction of thermos bottles, etc.

Before discussing some of the applications of the laws of the flow of heat to the design and construction of electric

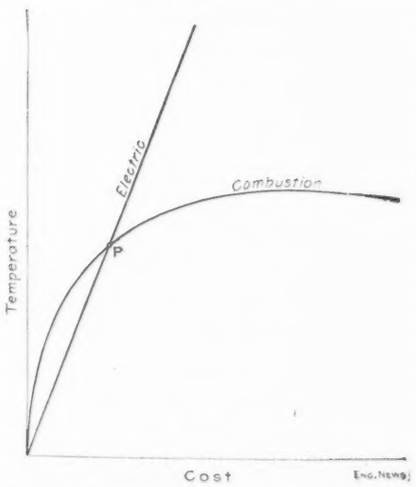

FIG. 1. OPERATING CHARACTERISTICS OF ELECTRIC AND COMBUSTION FURNACES

furnaces, let us summarize briefly the general features of the furnaces themselves. In general, there are two classes —resistance and arc furnaces. In the former the heat is generated in the interior of a conductor, due to the resistance offered by the material to the passage of a current through it. The ordinary incandescent electric lamp is a simple illustration of the generation of heat in this way. In the arc furnaces the heat is generated by the passage of a current through a gap formed between the ends of two conductors; the bridging of this gap by the current is called the electric arc. The ordinary arc lamp used in streets and halls is a simple illustration of the generation of heat in this way.

The general characteristics of these two classes of furnaces are as follows: In the resistance furnace the current may be passed through the material itself which is to be treated, or it may be passed through a permanent near-by conductor, and transmitted to the material to be treated by radiation, conduction and convection.

When the heat is generated in the material itself, the heating becomes very efficient, practically 100%, as all the heat is generated in the body itself, where it is wanted. This is therefore the most efficient method; it is also generally the most rapid, as no time is lost for the heat to penetrate by the slow process of conduction, from the outside to the inside; it is generated in the inside, and it can be generated very fast by simply increasing the current. Hence in some respects it is the ideal method. As long as the material remains solid, there is apparently no limit to the temperature which may be reached, for by continuing the passage of the current, heat continues to be generated, and if it cannot escape, it accumulates, thereby continually raising the temperature until the losses equal the input. This is the case in the graphite and carborundum furnaces, in which exceedingly high temperatures are obtained, estimated to be from 2300° to 4000° C.

If, however, the material through which the current passes becomes liquid, generally in an open channel, there is a very decided and sometimes very serious limit to the temperature which can be produced, for when the current reaches a certain value, dependent on the cross-section and the density of the material, a formerly unrecognized force comes into play, which contracts the column of liquid until it is severed completely, and this, of course, interrupts the current. This peculiar phenomenon was studied by the writer some years ago, and termed by him the "pinch phenomenon," by which name it is now generally known. By submerging these channels of liquid deeply below the surface, the writer found that this pinching force may not only be prevented from interrupting the circuit, but may even be used to cause the liquid in the confined channel to flow out of it as quickly as it is heated, whereby it also produces much desired circulation. (See "A New Type of Furnace," *Trans. Amer. Electrochem Soc.*, 1911, p. 255.) Such a furnace, then, has the desirable qualities of one with solid resistors, besides some new qualities due to the rapid circulation of the heated liquid.

The electrodes of such furnaces, which conduct the current from the outside of the furnace to the inside, are one of the most important elements, and also one of the most troublesome. To dispense with them, therefore, seemed a great improvement. This is accomplished in the induction furnace, and is its chief advantage; in such furnaces the current which does the heating is generated by induction in the metal in a trough, forming a secondary circuit through which the current can circulate; hence it requires no direct connections with outside circuits. It therefore has some advantages over furnaces which require electrodes. Among its disadvantages are: Its complicated construction and greater cost; the difficulty of preventing excessive losses of heat because the heated material necessarily exposes a very large surface to such losses; its low power factor, which means larger and more expensive electric machinery, especially so for the larger furnaces, etc.

The characteristics of the arc furnaces are briefly as follows: The temperature of the arc is always that of the volatilization of the material of the electrodes between which the arc plays, and as these are generally carbon or graphite which have extremely high vaporization temperatures, it follows that the temperatures developed in such arc furnaces are exceedingly high—generally far above what is required. This heat is, however, all generated in the arc itself and at the surfaces between which the arc plays;

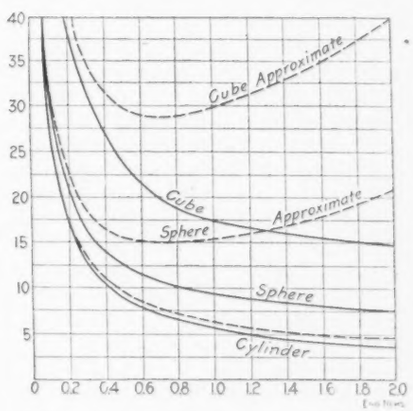

FIG. 2. CURVES SHOWING THE CONDUCTION OF HEAT THROUGH FURNACE WALLS

hence it can reach the main body of the material to be treated only by radiation, conduction and convection, and this necessarily takes time. In heating liquids with an arc, much of the energy must necessarily pass upward, hence is not utilized, and even tends to destroy the roof of the furnace. Moreover, heating a liquid from the top surface is not the most rational way, as the heat travels downward with difficulty and quite slowly. Hence it takes time for the heat to penetrate; this is also the case in open-hearth furnaces. The electrodes in arc furnaces are consumed, and therefore require continuous feeding, or else the arc goes out. Some and perhaps considerable of the electric energy for such furnaces is necessarily consumed in volatilizing the electrode material, although part of this energy may be again recovered.

In many of the chemical reactions which it is intended to have take place in furnace processes, more particularly in those conducted in electric furnaces,

energy is consumed by being stored up in the product formed. In the formation of calcium carbide, for instance, part of the energy is stored as chemical energy in this material, and it can be set free again later as desired, as light or heat. Sometimes—as in the reduction of aluminum, for instance—this stored energy becomes very great. An electric furnace must therefore also supply this energy, besides merely generating the heat required for the reaction to take place.

Some of the chief differences in the characteristics of combustion furnaces and those operated by electric energy are shown in Fig. 1. Let vertical distances represent temperatures, and horizontal ones the costs of heating a given quantity of a material to those temperatures. The curve for the combustion furnace rises quickly at first, showing low and only slowly increasing costs. For the higher temperatures it becomes flatter, showing rapidly increasing costs and, finally, a maximum temperature is reached beyond which it is not possible to go, as the temperature would diminish again. This latter point is reached when the air-blast is so great that the flue gases carry off the heat as fast as it can be generated by the fuel. When this point is exceeded, the fire goes out, as is illustrated by the blowing out of a candle flame where the volume of air is so great that the flame can no longer heat it, hence the wick chills and the flame goes out. These maximum temperatures are approached in steel furnaces; at these high temperatures the cost increases very rapidly; regenerators, for instance, will increase the temperature, but at considerable cost.

A corresponding curve for the electric furnaces would be approximately a straight inclined line intersecting the other. This means that the cost increases roughly proportionately with the temperature, and there is no definite maximum within practical limits. Hence for the lower temperatures the combustion heat is generally the cheaper; at a certain higher temperature they are equal; above that the electric heat is the cheaper, and for very high temperatures it is the only available means. For temperatures above this intersection point the cheapest method, therefore, is to use a combination of both, fuel being used for the lower temperature heat, and electric energy for the higher. This is what is common practice now in the electric steel industry, in which the cold metal is first melted by means of fuel heat and then transferred to the electric furnace for treatment at the higher temperatures.

Other characteristics of the electric furnaces are that there are no chimney gases with their attending losses, including those carried away by the useless nitrogen; there is no lighting of fires necessary; the generation of heat is accomplished very quickly; the atmosphere is neutral; the control of the heat is far more simple and perfect, etc.

As was stated above, the thermal efficiency of an electric furnace is the most important feature from the standpoint of the designing engineer, as it is the cost of the energy which is generally the criterion as to whether it will pay to use the electric furnace; an increase in the thermal efficiency means a decreased cost of this expensive form of energy. Hence, after the metallurgist has established the necessary conditions as to temperature, quantity of heat, interior capacity, etc., it is for the engineer so to construct the furnace that the heat losses will become as low as practicable.

As all electric furnaces are or should be inclosed, there are two sources of loss of heat—the heat which flows out through the walls, and that which flows out through the electrodes.

Until a few years ago our knowledge of the data, laws and rules of construction concerning these two losses of heat were so crude and unsatisfactory that the writer made analytical researches to determine the underlying principles and laws governing correct design, the results of which showed that in part our former practice was positively wrong, and had

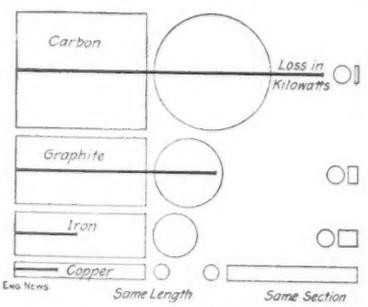

FIG. 3. SIZE AND POWER-LOSS COMPARISONS OF FOUR ELECTRODES FOR A GIVEN FURNACE

led us away from, instead of toward, the correct design. These researches have been fully described and published elsewhere by the writer; the results may be briefly summarized as follows:

The general law for the quantitative determination of the flow of heat through a body has been given above. The difficulties in applying it to the heat leakage through furnace walls lie in the lack of proper units and physical constants of materials, and in the fact that with thick walls, as are used in furnaces, the cross-section of the path of the flow of heat increases greatly from the inside surface to the outside. Suitable units have now been proposed and, while the physical constants are still badly needed, some fairly good ones exist and others will probably be forthcoming.

Concerning the flaring cross-section of the path of the flow, the usual rule has been to take the arithmetic mean between the inside and outside. Believing this to be unreliable, the writer some years ago determined the strictly correct formulas for such varying cross-sections ("Heat Conductances through Walls of Furnace," *Trans. Amer. Electrochem. Soc.*, 1908, p. 215) and found that, while the old rule was approximately correct for very thin walls, it was in error 100% and more for thick ones. The formulas were therefore sorely in need of correction. For a rectangular or spherical furnace the correct mean cross-section was found to be the geometric mean, not the arithmetic.

In Fig. 2 the vertical distances are proportional to the heat losses, and the horizontal ones are the wall thicknesses in terms of the inside diameter, or inside edge of a cube, the curves being limited to spherical, cubical and cylindrical furnaces, as representing the three typical forms. The dotted curves show the results when the usual formula is used, while the solid ones are those for the correct formulas.

It will be seen that at first the loss decreases very rapidly as the wall thickness increases, the curves being very steep. But when the thickness becomes relatively great, the reduction of the losses by a further increase in thickness becomes very small, and a point is reached when it would unquestionably cease being profitable to continue to increase the insulation.

After these correct formulas were published an English engineer applied them to the insulation of steam pipes, and claimed to have found thereby that Americans over-insulate their steam pipes; that is, that the cost of this excessive insulation is greater than is warranted by the heat saved thereby.

It will be seen that not only is the divergence of correct and approximate curves very great for the greater thicknesses, but the dotted lines actually have a minimum point, after which they rise again, which of course would be absurd, as it would mean that a further increase of wall thickness would actually increase the losses again. This shows the danger of using approximate formulas. The curves for the cylindrical forms are not directly comparable with the others, as they are for a cylinder of unit length, and must therefore be multiplied by the length, and the heat losses through the ends must be added.

[Note—For simplicity, Mr. Hering discusses heat conduction through walls, with the inner and outer surface temperatures known, and not heat dissipation from exterior surfaces. This is a factor yet to enter the logical design of electric-furnace walls—the resistance to the flow of heat from the exterior surface to air, involving the phenomena of radiation and convection. Unit surface resistance to heat flow in some cases may seem to be found rather lower than the specific resistance of the wall material to conduction, as is indicated by studies made by

the U. S. Geological Survey (reported in Bulletin 8 of the U. S. Bureau of Mines; see Engineering News, May 11, 1911, p. 568). It was there shown to be better to fill up the air spaces between walls of a boiler setting with some material like sand or ashes, as less heat passed out by conduction through this material than by radiation across the air space. Conduction depends on the difference in temperature of hotter and cooler parts, while radiation depends on the fourth power of absolute temperature difference. However, it has been shown (in a paper by Mr. Hering, "Flow of Heat through Contact Surfaces," printed in "Metallurgical and Chemical Engineering," Jan., 1912) that unit resistance across contact surfaces of solids, or solids and gases, is much greater than the specific resistance of wall material. The effect noted in the boiler-setting case then may be due to the large number of contact surfaces in the filling.

Convection phenomena are but those of conduction modified by a movement of the conducting media induced by gravity. The succession of cooler particles replacing hotter ones increases with temperature difference for any given construction, though various mechanical features may be introduced to minimize or increase flow. Therefore, it is quite possible that convection loss from a surface increases as some higher power of the temperature difference. The effect of these phenomena may modify curves made to show total losses through and from walls, rather than conduction alone. It is also possible that the total effect could be shown somewhat like the dotted curves in Fig. 2; that is, there might be a point beyond which the total losses actually increase with external diameter or wall thickness. It is certain that many engineers believe that, in the insulation of steam pipes, for instance, a point is reached where the larger surfaces exposed so increase the radiation and convection losses that the total loss is greater than with a thinner protecting wall. We are informed that Mr. Hering is at present making studies of the effect of surface phenomena on design.—Ed.]

A further study of these results shows how important it is, when conduction loss is important, to reduce the inside of the furnace as much as possible to hold the required charge; that is, one should not make the interior any larger than necessary, because the wall thickness, to keep the loss down to the same amount, increases very rapidly as the inside becomes larger. Another important result is that for the same *percentage loss* the wall thicknesses become enormously larger for the smaller furnaces; hence, as far as these losses are concerned, it is far more economical to use one furnace of the total capacity than to use several smaller ones which are together equal to the large one. For the same wall thickness, relatively to the inside dimensions, the losses per unit capacity—that is, per pound of metal melted—diminish rapidly as the furnaces become larger.

The loss of heat through and in the electrodes is a complicated matter. These electrodes, which extend from the cold outside to the hot inside, generally have to carry very large currents; they ought for this reason to be made of a good electric conductor, large in section and short, in order not to waste energy due to their electric resistance. On the other hand when thus made, they carry off large quantities of heat from the interior of the furnace, because a good electric conductor is generally also a good heat conductor. When they lead off much heat, it chills the product in the interior of the furnace, thereby diminishing the available interior space—that is, the capacity—and the heat efficiency becomes poor. The conditions for leading off as little heat as possible are directly opposite to those mentioned above for diminishing the electric resistance losses; that is, they should be made small in section, long, and of poorly conducting material.

In view of these conflicting conditions the question arises: What are the conditions under which the total losses, made up of both the electric and the thermal losses, are the least? With the aid of the calculus, these conditions for the minimum total loss can be readily determined under simplifying assumptions. These determinations were made by the writer some years ago (see "Laws of Electrode Losses," *Trans. Amer. Electrochem. Soc.*, 1909, p. 265) and, although they showed that our former practice had in many respects been entirely wrong in having led us away from rather than toward the correct result, it is believed to be generally conceded now that they are correct, and that our former practice was not. It afforded a good illustration of the importance of first making a thorough mathematical analysis, when the conditions are complicated and conflicting, before formulating practical rules of thumb for the constructor.

The chief results are as follows: Heat is generated by the current in the electrode; this, being generally at a lower temperature than the interior of the furnace, flows out at the cold end. As long as the end of the electrode which is in the interior of the furnace is cooler than the heated product under treatment, heat must necessarily be abstracted from this product, and will flow out through the electrode, thereby chilling the product. This latter loss of heat could be stopped entirely if the hot end of the electrode were at the same temperature as the heated product, for heat will flow only when there is a difference of temperature. If, therefore, the electrode is given such a cross-section and length that the heat generated in it by the current raises the inside end to the furnace temperature, then this desired result of stopping this abstraction of heat from the furnace product will be accomplished.

At first thought it seemed absurd actually to increase the electrode resistance in order to save energy. The analysis, however, showed that by thus intentionally increasing one of the losses, the other was reduced in a greater proportion; hence the total was less, and became a minimum when the above-mentioned conditions were fulfilled. There is a simple water analogy (though not a perfectly parallel one). Suppose that to the bottom of a tank an open pipe is connected. Let the required conditions be that this pipe cannot be closed, yet that no water shall flow out of the tank through the pipe. This can be accomplished by forcing water into this pipe, from other sources, through T connections, at such a rate that the pressure at the tank end of the pipe will be equal to that in the tank. A static pressure is thus produced dynamically.

Former practice had led to making the electrodes larger and larger, to keep them cool; this made them more and more costly and more difficult to handle. The above analysis shows that they should have been made smaller instead, so as to stop the loss of heat from the furnace product where it is wanted; the heat generated in the electrode costs less than that in the furnace, as it has to be transmitted (as electric energy) over a shorter distance. Such reductions in the size of electrodes result in large annual savings not only of power, but of electrode materials also. And it increases the valuable available space in the furnace by not chilling a more or less large part of the product.

This analysis brought to light another fallacy. Formerly it was claimed very positively by certain parties that graphite was a worse material to use than carbon, on account of its much higher heat conductivity; it was claimed to "chill the product too much," and therefore very wasteful of energy. The above analysis showed that this, too, was an error, as this chilling may be entirely prevented by proper proportioning; and when thus proportioned graphite is even less wasteful than carbon.

The explanation of this is that the minimum losses and the best proportions do not depend on either the electric or the thermal conductivities alone, but on certain relations between them. Neither property alone is a criterion. This brought out the surprising fact that the best electrode materials, from the standpoint of the least possible electrode losses, and the smallest amount of electrode material, were the metals; and of these, copper, the best of all heat conductors, was decidedly the most economical. Hence electrodes should be made of metals whenever possible, if economy of power and material is an object. This gives the resistance furnace an important advantage over those using the arc.

Some idea of the quantitative results of those researches are shown in Fig. 3, which gives the sizes and losses of power, for a given furnace, for four different materials, the comparisons on the left

being made on the basis of the same length; and those on the right, on the basis of the same cross-section; the energy losses, shown by black lines, are the same in both.

In conclusion, attention may be called to the fact that although, as a rule, electric heat is more expensive than fuel heat, yet in electric furnaces it is generally possible to apply the heat much more economically, and greatly to reduce the thermal losses, by proper and careful design, so that the total cost of the thermal operation in many cases becomes less, and that is after all the deciding factor in most cases. When a furnace is properly designed to reduce the thermal losses to the least possible, it is believed by the writer that it will soon be economical to replace some of the present fuel furnaces by electric furnaces for commercial work, even when the electric power has to be purchased from the supply in cities. There are, of course, other factors involved also, such as the reduction of labor, the better quality of the materials produced, the rapidity of heating, etc., all of which should be taken into consideration.

The development of the commercial electric furnace will, therefore, depend largely on the work of the engineer to design it with a view to obtaining the best possible economy in cents per pound of final product, and in this the reduction of the losses is one of the chief factors.

Waterproofing a Masonry Surface by the aid of compressed air is being carried on by the Moore Mica Paint Co., of 76 William St., New York City. According to a description of the process furnished us, a hood is placed tightly over the leaky portion of a concrete or masonry wall to which a special paint has been previously applied. Compressed air is then admitted under the hood, and by its pressure forces the paint into the pores of the masonry.

Filling Mine Workings under Railway Bridges with Concrete

By C. L. Camp*

In the city of Scranton, Penn., the lines of the Delaware, Lackawanna & Western R.R. are in two places carried across bridges which rest on piers and abutments footing on the comparatively thin roofs of abandoned coal-mine workings. In order to insure the safety of these footings against possible settlement, it was decided to fill the openings solid with concrete. This work was successfully carried out in January, 1911.

The two bridges in question are known as Bridge No. 60 and the Lackawanna Ave. Viaduct. The former is a six-track deck girder bridge with a concrete floor, at the junction of the Main Line and the Bloomsburg Division, and carries the tracks over the Lackawanna River. The Lackawanna Ave. viaduct is an overgrade bridge of concrete and steel construction, carrying Lackawanna Ave. and two street-railway tracks. All of the viaduct and the westerly piers and abutments, only, of Bridge No. 60 were undermined.

There are a number of veins of coal under these bridges, and mining has been done in all of them. The Diamond and Rock are the upper veins, nearest to the foundation footing. The elevation of the railroad tracks at Bridge No. 60 is 745, and the elevation of the base of the westerly abutment is 715, while the elevation of the roof of the Diamond Vein is 672, leaving about 43 ft. of foundation under the abutment. The elevation of the Rock Vein is 640, leaving 32 ft. between these veins. Conditions at the viaduct are similar. The roof of the Diamond Vein is a soft sandstone.

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The method of handling this work was as follows: A 12-in. bore hole was sunk near each bridge and concrete mixers placed over them. That portion of the workings to be filled was cleaned out, and 36-in. gage tracks were laid from the bore hole to each chamber on a down grade from the bore hole so as to facilitate the handling of the concrete. Bulkheads, as shown in Fig. 1, were then built across the chambers at the boundaries where it was decided the load effect of the bridge stopped and the concreting commenced.

The cars and track material were taken into the mines through a slope which comes to the surface, about 800 ft. northeast of Bridge No. 60. This slope ran to the Rock Vein, but did not have a direct connection with the Diamond Vein; an opening was cut from the slope to the Diamond Vein. The concrete was dropped directly from the mixer into cars below and hauled to the chambers. So far as possible, the material was simply dumped in the workings, and the tracks raised. After the tracks had been raised as high as possible, the concrete was dumped and shoveled by hand into place. It was mixed dry enough to stay in place after being shoveled into the heading and tamped slightly. The work was carried on at both bore holes simultaneously, in each vein. About 11,500 cu.yd. of cinder concrete mixed in the proportion of 1 cement, 2½ sand and 7 cinders, were required to fill the openings. Fig. 2 shows one of the finished sections of the concrete fill.

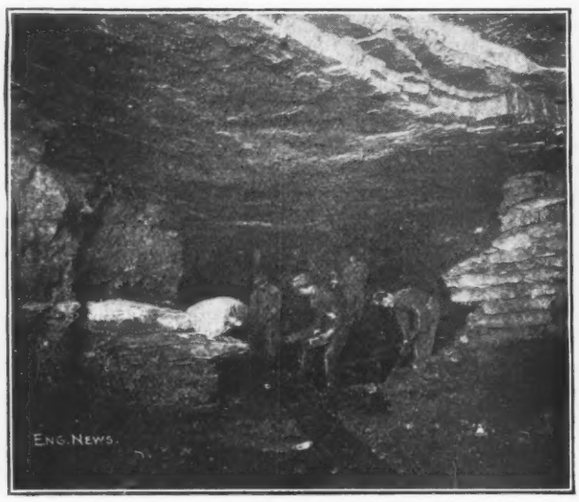

Fig. 1. Building Bulkheads to Hold Concrete in Filling Mine Workings

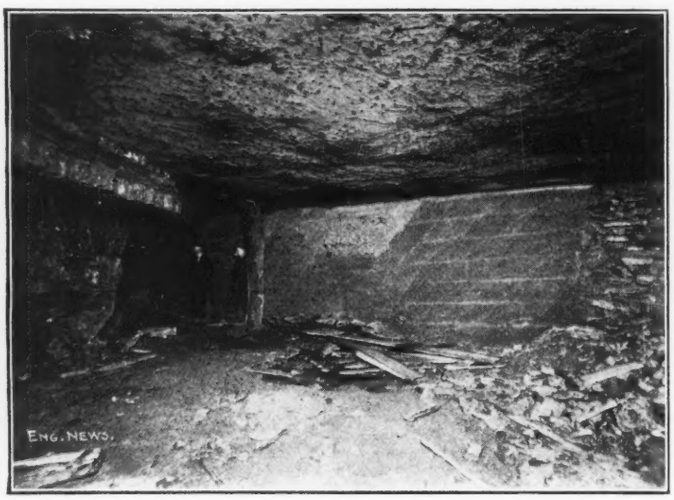

Fig. 2. Finished Concrete Filling in Old Mine Working

Babylonian Brick, according to H. D. Searles-Wood, in a paper in the Journal of the Royal Sanitary Institute, were not very different from those worked out by the Royal Institute of British Architects. Babylonian standards ranged from 8¾x5⅝x2¼ in. to 9.6x4.9x3 in. The range in the British standards is from 8⅞x4⅛x2⅝ in. to 9x4⅜x2¼ in.

Electric Smelting in Sweden

By C. Van Langendonck*

An electric stack furnace for the reduction of iron ore has been in service a year at Trollhattan.

The furnace consists essentially of a shaft and a crucible or hearth. The shaft is a steel shell 28 ft. high, lined with firebrick. It is suspended from steel girders. Below this is a broad hearth with arch roof. The electrodes project through the roof into the charge.

Gases are drawn from the top of the stack and blown into the crucible. This circulation of gas helps to heat the charge above the crucible, cools the roof of the latter, and assists in the reduction of the charge in the stack.

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The electric iron-smelting plant erected at Trollhättan by the Swedish Association of Ironmasters ("Jern-Kontoret") has been in operation now for about a year, and the results have proved very successful. Details of the design and operation of the plant were made public a few months ago by J. A. Leffler at a meeting of this association. The author is indebted to that paper as the basis of the present article.

The site of the Trollhättan iron-ore reduction plant has direct railway connection with the Trollhättan station by two broad-gage tracks. One is for the transport of fuel to a storage house, and the other is for conveying other materials to the works and shipping iron out. The fuel-storage shed is designed for a capacity of about 247,000 cu.ft., which corresponds to six months' supply. The fuel, charcoal, is conveyed from the cars into the storage house by two band conveyors, with parts of cold-rolled steel. From the storage house, the charcoal is elevated to the furnace top in suspended baskets running on a wire rope.

The ore is carried in barrows, in the usual manner, from ore heaps to the crusher plant, from which it is elevated to the furnace top in a car running in an inclined track. A narrow-gage industrial track has been constructed for the transport of pig iron and slag to the iron storage and slag dump respectively. Fig. 1 shows the fuel storage at the right, the furnace house at the right and the ore crusher between, back of the inclined railway.

The furnace building occupies an area 80x52 ft.; the height from the ground floor to the furnace top is 46 ft., and the total height to the eaves is 70 ft. The high-tension apparatus and transformers are placed in a separate section of the building (front, Fig. 1). From the two transformers for the furnace, the low-tension conductors enter the furnace-room proper through two large openings in the wall.

Two separate portions are to be distinguished in the construction of the furnace, (1) the shaft and (2) the crucible or hearth. The shaft consists of a shell, about 28 ft. high, of steel plates, ⅜ in. thick around the stack and ½ in. around the boshes. At the top it is riveted onto an octagonal supporting ring of steel channels by which the shaft is supported. The sidewalls of the furnace room are built out in pilasters, 30 ft. high, which carry two built-up beams, 4 ft. 4 in. high, with a free length of 35 ft. 5 in. Around the furnace these are joined to form an octagon on which rests the channel-iron ring mentioned above.

The shaft is lined with firebrick to a thickness of 1 ft. 2 in. in the boshes and 1 ft. 6 in. in the stack. At the top the shaft is a Tholander charging bell and cone, which is raised or lowered by means of a capstan driven by a 2½-hp. reversible three-phase motor. The cone is connected to the capstan by a ½-in. wire rope provided with a hook, which is removed between the charges so as to be out of the way of the coal baskets which pass close to the center line of the furnace.

The crucible rests on a concrete foundation. Like the shaft, it is surrounded by a sheet-iron shell, ⅜ in. thick. At the top this shell is reinforced by an 8x¾-in. iron band to take up the pressure of the arched roof. The lining of the hearth is of firebrick next to the shell and foundation, with an inner lining of magnesite brick, while the cup-shaped bottom is formed of a mixture of magnesite and pitch rammed in so as to extend for some distance up along the walls. The roof is constructed of firebrick. The hearth and shaft (boshes) are joined by means of a sand seal.

The four electrodes project through the crucible roof at an angle of 65° to the horizontal (Fig. 4). Each electrode is built up of four carbon rods about 6½ ft. long and of square cross-section, giving a total electrode section 2 ft. 7 in. square.

The rods are planed smooth and cemented with molasses and graphite paste. The sides at one end of the completed electrode, are planed smooth and between the carbon and cable contacts is placed fine copper-wire cloth. The cable ends are wedged between the copper cloth and a cast-steel holder frame. The latter, in turn, is supported on a frame movable up and down between two guides placed on each side of the electrode. At the openings in the roof the electrodes are surrounded by copper water jackets, provided at the top with asbestos packing to prevent the leakage of gas. For reasons shown later, the electrodes are not frequently shifted, so that more elaborate stuffing boxes are not needed.

Gas is drawn by a fan from the gas outlets at the top of the stack and blown into the crucible. Consequently the quantity of gas passing any given section of the shaft can be varied within certain limits by varying the speed of the fan. This circulation of gas has two principal objects: (1) The gas blown into the crucible is there heated only to give off its heat to the charge in the shaft in passing up through it; (2) the gas cools

FIG. 1. THE TROLLHATTAN ELECTRIC IRON SMELTING WORKS

the roof and thus protects it from overheating. This cooling action of the gas is due in part to the absorption of heat for raising the temperature of the gas, and in part to the decomposition of CO_2 and H_2O of the gas in contact with the incandescent carbon in the crucible. The consequent formation of CO assists in the reduction of the charge in the stack.

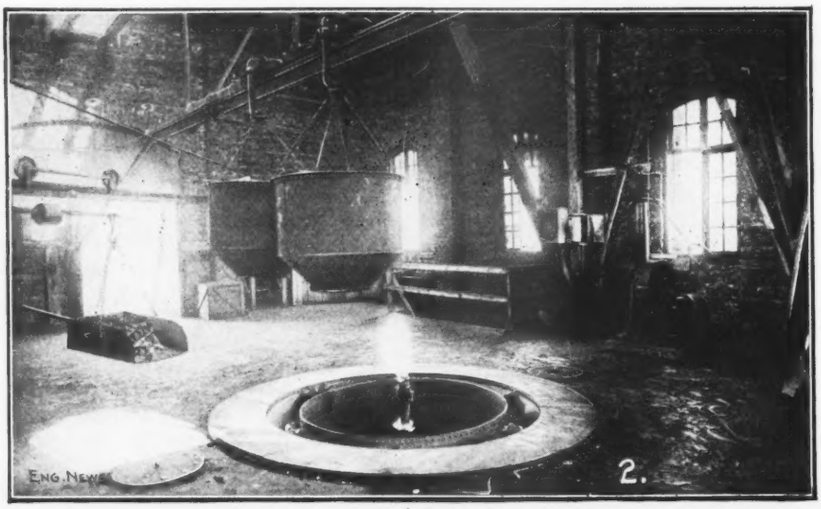
Two gas outlets from the top of the stack lead to a large dust-collecting chamber from which a fan blows the gas into a circular pipe surrounding the crucible (Fig. 5). From here it enters through four tuyeres at the springing line of the crucible roof. In the original construction, four gas pipes led into the cooling jackets around the electrodes to cool them and the surrounding brickwork. These pipes were, however, soon disconnected, as it was found that the hot electrodes were attacked too strongly by the gas blown through them.

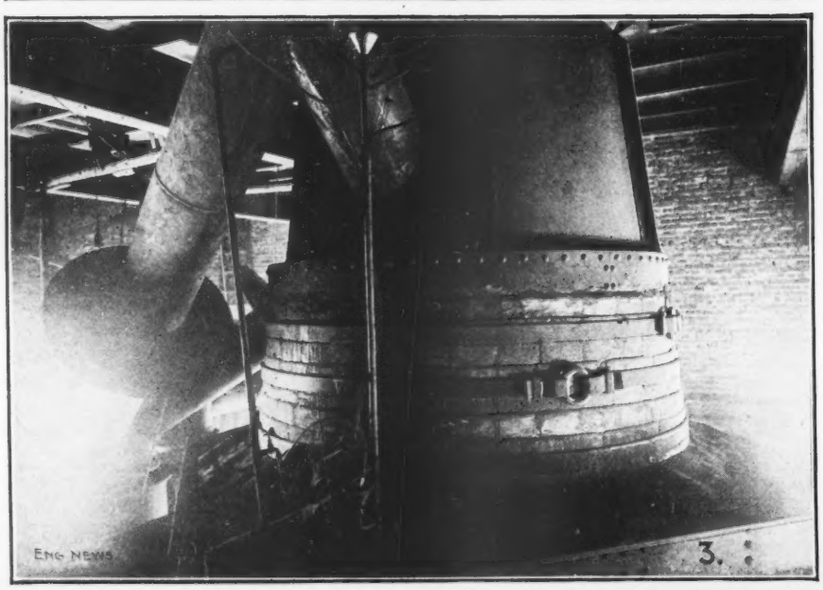
Whatever excess gas is formed, escapes from the dust-collecting chamber through a pipe extending above the roof, where it burns.

The fan was designed to deliver, at a speed of 2500 r.p.m. and a consumption of 8 hp., a volume of 2480 cu.ft. of gas per minute against a back pressure of 13 in. of water, the temperature of the gas being assumed to be 200° C., and its composition as equal volumes of CO and CO_2.

On the charging floor are eight 140-cu.ft. ore boxes, with a dump car running on a track above them. Into this car the elevator discharges its ore from the crusher. There are two electric capstans on this floor, also one for elevating the ore truck and one for bringing up charcoal buckets. Both capstans are driven by the same 16-hp. motor. The water tank of the plant is on this floor also.

The molten iron is led in conduit (Fig. 5) for a length of about 20 ft. to a small





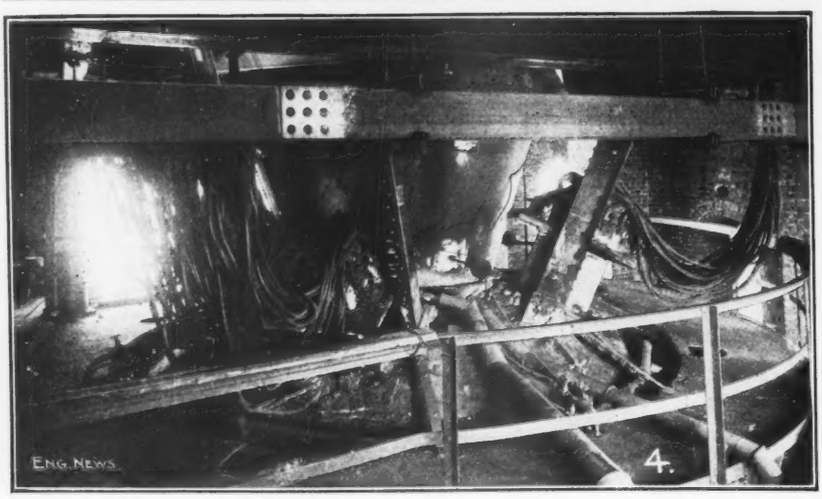


FIG. 2. CHARGING FLOOR FIG. 3. TOP OF STACK
FIG. 4. BOSHES AND TOP OF CRUCIBLE

FIGS. 2 TO 5. TROLLHATTAN ELECTRIC STACK FURNACE

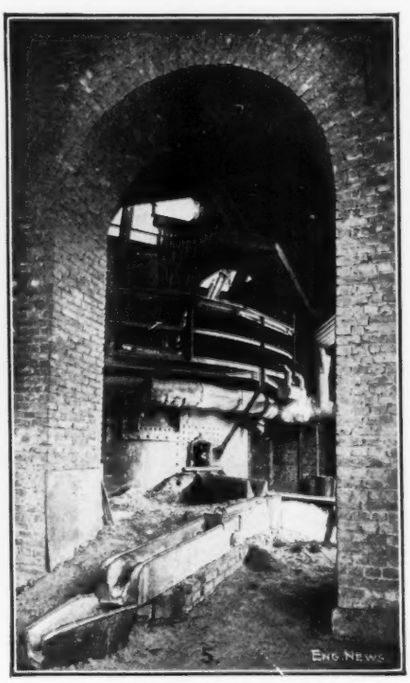


FIG. 5. CRUCIBLE AND TAP HOLE

swinging spout in the foundry, which is in a single-story addition to the furnace building (rear, Fig. 1). There are six beds Grönwall, Lindblad and Stalhane, and containing 28 pigs. Each section is provided with its distributing feeder, to which the iron is conducted through the swinging spout. For tapping the slag, the crucible is provided with a slag hole from which the slag may be tapped into ordinary slag bogies. During a large part of the time, however, the charge has been high in iron and the quantity of slag correspondingly small. Under these conditions separate tappings of slag have not been made, but the slag which has accompanied the iron has been skimmed off and allowed to flow into a sand trench.

Three-phase 25-cycle 10,000-volt current is obtained from the government power station at Trollhättan. The two furnace transformers have a 1100-kv.a. rating, with a guaranteed overload capacity of 1375 kv.a. for one hour.

The electrical instruments required for observing and regulating the working of the furnace and electrodes, together with all handles and handwheels for regulating the current, are placed on an instrument board on the working floor (Fig. 4). In the so called furnace office on the floor above, are placed the self-recording kilowatt-meter and two electricity meters with a maximum indicator. In the same room are placed two galvanometers for the eight thermo-electric elements. At the side of each pyrometer hole on the furnace is a smaller opening, which was used for observing the gas pressure, and for collecting samples of gas.

The plant as described cost about $86,000.

The furnace was invented by Messrs. Grönwall, Lindbald and Stalhane, and the following principles of design have been stated by the Electro Metals Co., Ltd., of London:

(1) As all known materials become good conductors at a high temperature, the construction must be such that the current does not pass away through the lining during the working. (2) The construction must be such that the charge itself protects the lining from destruction through radiation from the electric arc or through conduction; otherwise it would be necessary to employ water cooling with consequent waste of energy. (3) The charge must not press too hard against the electrodes to permit the formation of an arc. If this condition is not fulfilled the voltage becomes unduly low, the electrodes and conductors assume inordinately large dimensions, and the working becomes irregular. (4) In electric working the carbon charged with the ore cannot burn, and for obtaining a product of uniform quality it is, therefore, necessary to have a hearth of sufficiently large dimensions, to serve as a mixer. Otherwise every irregularity which inevitably occurs in charging will influence the carbon contents, etc., of the product.

In order to fulfill these conditions the hearth is constructed in the shape of a comparatively large crucible, covered by an arched roof. When the charge sinks down into the crucible it spreads there in such manner that a free space is always formed between the charge and the brickwork of the roof. The electrodes are introduced into the crucible through the brickwork at points where it is not in contact with the charge, and enter the charge on the free surface exposed. By means of this construction the above-enumerated conditions 1, 2 and 3 are fulfilled, and as the hearth can be made comparatively large, condition 4 is also fulfilled.

Another important feature in a furnace of this kind is the regulating of the energy supply. As the furnace must necessarily work with a considerable gas pressure, the usual method, consisting of raising or lowering the electrodes, cannot be conveniently employed, as it would be too difficult to keep the packings tight around the electrodes. A system has been elaborated by which the electrodes are generally adjusted in accordance with their wear, but all other regulating is accomplished by varying the voltage of the current supply. This is done by cutting out windings on the high-tension side of the transformers, and the arrangements are such that the different phases can work simultaneously with different tensions; for instance, 80 volts on one phase and 70 volts on the other, etc. This method of regulating the current has greatly facilitated working the furnace.

Apart from the small quantity of coke used for starting the furnace, charcoal has been used exclusively for the reduction. The charges are made by volume, but all of the charcoal is weighed and analysis made every day; moisture and ash have occasionally been unduly high, the latter owing to stones and gravel mixed with the charcoal. The ore and limestone are broken to nut size in a powerful crusher.

Need of repairing the crucible has been slight. During a period of nearly five months' continuous working, only 18 hours have been required for repairs, which has been regarded as eminently satisfactory. The height and other dimensions of the shaft have, in the main, proved correct for normal conditions of fuel and ore. The experience with this furnace further appears to indicate that with this size four electrodes is a minimum number, six electrodes with three-phase current probably being better. This would distribute the heat more uniformly in the charge and there would be less disturbance from transformer troubles. Losses through cooling water would, in this case, probably be increased, but this would undoubtedly be more than counterbalanced by the advantages gained.

By the use of burned instead of unburned limestone, the economy of the furnace is increased. The percentage of CO_2 in the gas circulated remains the same, for the CO_2 derived from the limestone is secured by the reduction of ore by CO. The saving is in the energy needed for burning the limestone.

Grouting Leaks in the Washington St. Tunnel under the Chicago River*

By William Artingstall†

In January, 1911, the work [on the reconstruction of the Washington Street tunnel] was sufficiently advanced to permit the operation of street-car traffic. At that time there were numerous leaks through the tunnel walls, which, under the terms of the contract, had to be absolutely watertight. Geo. W. Jackson, Inc., has at this time a force of men engaged in this work, and the method seems to be effective.

A grouting machine, air compressor, electric motor and small derrick mounted on a flat car belonging to the Chicago Railways Co. are run down into the tunnel after midnight. The machine (manufactured by the Cockburn company) consists of a drum into which the cement and sand are placed and the cover clamped down. Water is then admitted and the mass agitated by means of paddles mounted on a shaft, one end of which, extending through the drum, is fitted with a belt connected to an electric motor. A 2-in. hose is connected to a valve in the drum and leads to the connection at the grouting pad.

Where a perceptible amount of water is coming from one spot, the hole is cleaned out and enlarged to about 2 in. diameter. A felt gasket is then placed around the hole and the flange of a 5-in. pipe placed over the opening. The grout is forced through a 2-in. pipe fitted with a tee (capped at one end), which is fastened into the pipe. This 5-in. pipe is used only to hold the pad in place and has a jack screw fitted in one end for bracing against the opposite wall.

The amount of grout forced into the hole depends on the size of the hole to some extent, but some leaks take a large amount of cement. The pressure (about 110 lb.) is not kept on continually, but by applying it for intervals of five or ten minutes with a rest of about the same amount of time, grout can be forced into the leak at practically every trial. The pad and jack are left in place until it is necessary to remove them for the first cars passing through the tunnel at 5 a.m.

*From a paper on "The History and Reconstruction of the Chicago River Tunnels," in the November number of the "Journal" of the Western Society of Engineers, Chicago. The reconstruction of the Washington St. tunnel was described in Engineering News, July 21, 1910.

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Deterioration of Coal in Storage*

By H. C. Porter† and F. K. Ovitz†

Tests by the U. S. Bureau of Mines show that New River and Pocahontas coals lost less than 1% in heating value by open storage for a year, and lost practically nothing under water; Pittsburg gas coal lost nothing in six months' open storage; Wyoming bituminous coal slacked and crumbled in 2¾ years and lost 5.3% in heating value.

Spontaneous combustion begins with slow oxidation where the heat developed cannot be carried away.

Dust and fine coal expose large surfaces to oxidation. High volatile content does not seem to increase trouble. Moisture and sulphur have not been proved to have more than minor influence. Rehandling stored coal after the first oxidation largely prevents further heating.

Not many years ago, coal was commonly regarded as an extremely unstable material, subject to very serious alteration and losses on exposure to the elements. Similar views have been held in much more recent times. While probably the great majority of chemists and engineers today hold no greatly exaggerated ideas on the subject, there is a well defined suspicion that sufficient loss of volatile matter and sufficient deterioration by oxidation do occur in coal to be of industrial importance. For that reason, investigations were undertaken by the U. S. Bureau of Mines to determine accurately the extent of the deterioration which takes place in different types of coal from different sections.

Loss of Volatile Matter—First, a study was made in the laboratory of the loss of volatile matter from crushed coal during storage. A number of 20-lb. samples, representing a variety of types from widely separated fields, were broken to about ½-in. size at the mine, and immediately placed in glass bottles. At the laboratory, the accumulated gas was withdrawn and a free continuous escape of the volatile products permitted at atmospheric pressure and temperature. (The results of these experiments have been published by the bureau in Technical Paper No. 2, entitled, "The Escape of Gas from Coal," and will therefore not be given here in detail.) While several coals evolve methane in large volumes, especially in the early period after mining, the coal suffered in one year a loss in calorific value from this cause of but 0.16% as a maximum. It seems, therefore, that the loss due to escape of volatile matter from coal has been greatly overestimated.

Open and Submerged Storage—At the instance of the Navy Department, however, which is a purchaser of coal to the extent of some $3,000,000 annually and stores large lots in warm climates for long periods of time, more elaborate tests were undertaken to determine the total loss possible in high-grade coal by weathering. The extent of the saving to be accomplished by water submergence as compared to open-air storage was a point to be settled, and there had also arisen the question as to whether salt water possessed any peculiar advantage over fresh water for this purpose.

Coal-storage problems have assumed importance during the last few years on account of the uncertainties of supply due to strikes and transportation difficulties. The naval-coaling stations, the Panama R.R. Co., the Great Lakes commercial coal-distributing companies, large coke and gas or power plants at a distance from the coal fields and the railroads themselves, particularly those in the West, often keep 50,000 to 500,000 tons in storage.

The tests of the bureau were carried out as follows: Four kinds of coal were chosen: (1) New River, on account of its large use by the Navy; (2) Pocahontas, as a widely used steaming and coking coal in the East, and as being also the principal fuel used in the Panama Canal work; (3) Pittsburg, as a type of rich coking and gas coal; and (4) Sheridan, Wyo., as a sub-bituminous or "black lignite"—a type much used in the West. With New River coal, 50-lb. portions were made up out of one large lot, which had been crushed to ½-in. size and well mixed. These portions were confined in perforated wooden boxes and submerged under seawater at three navy yards, differing widely from each other in climate conditions. Also 300-lb. portions from the same original lot were exposed to the open air, both out of doors and indoors, at the same places.

With Pocahontas coal, test was made only at one point, the Isthmus of Panama, run-of-mine being placed in a 120-ton pile, exposed to the weather. Pittsburg coal was stored, as run-of-mine in open outdoor bins, of 5-ton capacity, at Ann Arbor, Mich., also in 300-lb. barrels submerged under fresh water. The Wyoming sub-bituminous was stored at Sheridan, both as run-of-mine and slack in outdoor bins, holding three to six tons each.

Every test portion was sampled each time in duplicate and in all cases, except the outdoor pile at Panama and the 300-lb. open-air piles of New River coal, the sampling was done by rehandling the entire amount. In the excepted cases mentioned, it was not thought fair to disturb the entire lot. Therefore at Panama, a vertical section of 10 tons only was removed each time and eight samples taken. In the case of the outdoor lots at the navy yards, a number of small portions, well distributed, were taken from each pile, mixed, and quartered down. Small lots and a fine state of division were conditions purposely adopted with the New River coal, so as to make the tests of maximum severity.

Moisture, ash, sulphur, and calorific-value determinations, were made on each sample. In the case of the New River coal, less than 1% of calorific value was lost in one year by weathering in the open. There was practically no loss at all in the submerged samples and fresh water seemed to "preserve the virtues" of the coal, as well as salt. There was almost no slacking of lump in the run-of-mine samples and the crushed coal in all cases deteriorated more rapidly than run-of-mine.

The Pocahontas run-of-mine in a 120-ton pile on the Isthmus of Panama lost during one year's outdoor weathering less than 0.4% in heating value, and suffered little or no physical deterioration of lumps.

The Pittsburg gas coal during six months' outdoor exposure suffered no loss whatever of calorific value, measurable by the calorimetric method used, not even in the upper surface layer of the bins.

The Wyoming coal lost as much as 5.3% in one of the bins during 2¾ years, and 3.5% even in the first three months. There was bad slacking and crumbling of the lumps on the surface of the piles, but where the surface was fully exposed to the weather this slacking did not penetrate more than 12 to 18 in. in the 2¾-year period.

No outdoor weathering tests have been made by the Bureau on coal of the Illinois type. Thorough tests, however, on this type have been reported by Prof. S. W. Parr, of the University of Illinois.

*From a paper presented, by permission of the director of the U. S. Bureau of Mines, at a joint meeting of the New York sections of the American Chemical Society, American Electrochemical Society, and the Society of Chemical Industry, New York City, Nov. 10, 1911.

†U. S. Bureau of Standards, Washington, D. C.

and A. Bement, of Chicago, both of whom find from 1.0 to 3.0% calorific loss in a year by weathering. Mr. Bement reports a slacking of lumps (in tests on small samples) of over 80% in one case and about 12% in another. It is probable that in this type, as in the Wyoming, the slacking in a large pile would not penetrate far from the surface.

Storage under water unquestionably preserves the heating value and the physical strength of coal. But it practically necessitates firing wet coal, and therefore means the evaporating in the furnace of an amount of moisture varying from 1 to 15%, according to the kind of coal. This factor is an important drawback to under-water storage with coals like the Illinois and Wyoming types, which mechanically retain 5-15% of water after draining, but in case of the high-grade Eastern coals, if firemen are permitted, as is ordinarily the case, to wet down their coal before firing, "so as to make," as they say, "a hotter fire," then the addition during storage of the 2 or 3% moisture which these coals retain would be of little consequence. Submergence storage is an absolute preventative of spontaneous combustion, and on that account alone its use may be justified with some coals, but merely for the sake of the saving to be secured by avoidance of weathering there does not seem to be good ground for its use.

Spontaneous Combustion*

Slow Oxidation—Losses in coal due to spontaneous heating are serious. Oxidation (probably in the main an absorption of oxygen by unsaturated chemical compounds) begins at ordinary temperature in any coal, attacking the surfaces of the particles and slowly developing heat. In a small mass of coal this heat can readily dissipate itself by radiation and no rise in temperature results. If radiation is restricted, however, as in a large pile densely packed, the temperature slowly rises. Now, the curve of oxidation rate, plotted against temperature, rises with great rapidity, and when the storage conditions are such as to allow a temperature of about 100° C. to be exceeded, the rate of oxidation is great enough, ordinarily, so that the heat developed overbalances the heat radiated. Then the temperature rises to the ignition point if the air supply is adequate.

The importance, therefore, can be seen of guarding against even moderate heating in the coal either from internal spontaneous causes or by radiation from external sources. Increased loss of heating value and of volatile matter occurs at moderately increased temperatures even though the ignition point is not reached.

Fineness—The amount of surface exposed to oxidation in a given mass depends on the size of the particles and increases very rapidly as the fineness approaches that of dust. Dust is, therefore, a dangerous thing in a coal pile, particularly if it is mixed with larger sized coal which forms air passages to the interior. There is a wide variation among coals in friability. In comparative rattler tests, Pocahontas, New River and Cambria County, Penn., coals produced nearly twice as much passing through a ⅛-in. screen as a sample from the Pittsburg seam. Mixed lump and fine (run-of-mine) with a large percentage of dust, piled so as to admit to the interior a limited supply of air, make ideal conditions for spontaneous heating.

Volatile Matter—High content of volatile matter does not of itself increase the liability to spontaneous heating. Recently inquiries about spontaneous combustion were sent by the bureau to more than 2000 large coal consumers. Of the 1200 replies, 260 reported instances of spontaneous combustion, 220 of them naming the coal. Of these 220, 95 were in semibituminous low-volatile coals of the Appalachian region, and 55 in Western and Middle-Western coals. This result shows at least no falling behind on the part of the "smokeless" type and no cause for placing special confidence in these coals for safety in storage.

A serious fire in cinder filling under a manufacturing plant in Pittsburg was recently investigated by the bureau; all the evidence pointed to spontaneous combustion, induced by external heat from a furnace. The cinders contained 40% of carbon. A similar fire occurred two years ago under a smelting plant on Staten Island, New York City, in which case the cinders contained 33% carbon. The cause was not definitely determined, but from the insurance reports spontaneous heating appears plausible. The volatile matter in the material could not have been a factor in these causes.

Pocahontas coal gives a great deal of trouble with spontaneous fires in the large storage piles at Panama. It is reported also by several large by-product coke concerns to be more troublesome in this respect than their high-volatile gas coals. The high-volatile coals of the West are, to be sure, usually very liable to spontaneous heating, but they owe this property to the chemical nature of the substances which compose the coal rather than to the amount of volatile matter. Strange as it may seem, a high-oxygen content in coal appears to parallel its avidity for oxygen and to promote, therefore, its tendency to spontaneous combustion.

Moisture and Sulphur—The influence of moisture and sulphur upon spontaneous heating are mooted questions much discussed but little investigated. Richters has shown that, in the laboratory, dry coal oxidizes more readily than moist, but the weight of opinion among practical users of coal is that moisture promotes spontaneous heating. Observation of the Bureau in many actual cases have not developed any instances where moisture could be proven to have had such an effect.

Sulphur, on the other hand, has been shown by these investigations to have, in most cases, only a minor influence. In a number of actual cases, samples of the heated coal from areas where the heat was greatest have been analyzed, both for total sulphur and for sulphates. The difference between these (unoxidized sulphur) was in no case less than 75% of the average total sulphur in the original. In other words, not more than a fourth of the total sulphur has entered into any heat-producing reaction. The possibility remains, however, that all of the sulphur which was oxidized was concentrated in one pocket of moist flaky pyrites, and thus sufficient heat was developed in one spot to act as an igniter. On the other hand, a Boston company using Nova Scotia coal of 3 to 4% sulphur has much trouble with spontaneous fires in storage, but a number of samples taken by the bureau from exposed piles of this coal in which heating had occurred showed that 90% of the sulphur was still unoxidized. Experiments in the laboratory, passing air over coal at 120° C. have developed enough heat to ignite the coal and no change was found in the form of the sulphur. While not entirely conclusive, these results point to a very minor contribution, if any, on the part of sulphur to spontaneous heating in coal.

Seasoning—Freshly mined coal and even fresh surfaces exposed by crushing lump coal exhibit a remarkable avidity for oxygen, but after a time become coated with oxidized material, "seasoned," as it were, so that the action of the air becomes much less vigorous. It is found in practice that if coal which has been stored for six weeks or two months and has even become already somewhat heated, be rehandled and thoroughly cooled by the air, spontaneous heating rarely begins again.

A large power plant in New York crushes its coal to pass a 4-in. screen immediately after unloading from barges, the fines and dust (50% or more) being left in the coal to be stored. This freshly crushed coal is elevated to iron hopper-shaped bunkers directly over the boilers where the air temperature very often reaches 100° F. As the coal hangs on the sloping sides sometimes three or four months at a time, it is hardly surprising that some of the bunkers are on fire practically all of the time.

Recommendations—With full appreciation of the fact that any or all of the following recommendations may under

*See Engineering News, May 4, 1911, p. 534, for studies of spontaneous combustion in Illinois coals.—Ed.

certain conditions be found impracticable, they are offered as being advisable precautions for safety in storing coal whenever their use does not involve unreasonable expense.

(1) Do not pile over 12 ft. deep, nor so that any point in the interior will be over 10 ft. from an air-cooled surface.

(2) If possible, store only lump.

(3) Keep dust out as much as possible; reduce handling to a minimum.

(4) Pile so that lump and fine are distributed as evenly as possible; do not allow lumps to roll down a pile and form air passages at the bottom.

(5) Rehandle and screen after two months.

(6) Keep away external sources of even moderate heat.

(7) Allow six weeks' "seasoning" after mining before storing.

(8) Avoid alternate wetting and drying.

(9) Avoid admission of air to interior of pile through interstices around foreign objects such as timbers or irregular brickwork; also through porous bottoms, such as coarse cinders.

(10) Do not try to ventilate by pipes, as more harm than good is often done.

The Prest-O-Lite Building Failure

By T. L. Condron*

The collapse of the reinforced-concrete building for the Prest-O-Lite Co., under construction at Indianapolis, Ind. Continued from ENGINEERING NEWS, Dec. 28, 1911, p. 782.

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Analysis of Stresses

The stresses in floor designs having reinforcing bars crossing each other in four directions cannot be determined by any of the common methods of calculations, but require first, that assumptions be made regarding the distribution of stresses, the correctness of which assumptions is, to say the least, open to question. Such floors can be built with great strength and stiffness, even though the stresses may be indeterminate.

Highly involved mathematical analyses of flat-slab floors have been published, which start out upon assumptions that may or may not be true. After all, the actual tests of such designs teach more than the most refined calculations so long as those calculations depend upon purely theoretical bases that may be entirely erroneous. In this particular design only two belts of reinforcement (the diagonal belts, were in the top of the slab over the heads of the columns. The other belts of bars at the column heads, were in the bottom of the slab and hence in compression instead of tension. On the other hand, a complication was introduced in that the column heads were square in plan, and their diagonals, instead of their sides, were in line with the reinforcement in the upper part of the slab. This is clearly shown in Fig. 4, where only the diagonal reinforcement and the so-called spider bars are shown.

A flat-plate floor supported by a series of columns with flaring heads or capitals, and so reinforced that the upper surface will resist tension, will be so stressed that there will be a region of negative moment over each head and of positive moment between the heads, with a line of inflection around each head. This line of inflection may be as shown in Fig. 4 and its distance from the edges of the supporting head may be as indicated by x, y, z, or by t, v, w. If there is no reinforcing in the top of the slab over the column heads and ample reinforcing in the bottom of the slab, there will be no line of inflection but the slab will simply rest upon the column heads and deflect between supports.

All analyses of the stresses in flat-plate floors should take account of these fundamental elements. Various designers have endeavored so to proportion and place the reinforcing bars as to secure the maximum efficiency of both the steel and concrete. However, there should always be a clear basis for such proportioning and placing of reinforcement, so that not only the designer, but any other intelligent engineer, can determine the stresses that result from the assumed loads. No designer should use purely arbitrary rules for proportioning structures unless he fully understands their meaning and considers them to be right and reasonable. It is true that long experience leads engineers to use certain involved formulas, without at the time considering how they were originally derived, but in forms of construction involving new and perhaps unproved formulas an engineer should be sure he understands the formulas he makes use of and be willing to stake his reputation upon their correctness and reliability.

The writer has applied to these floors as designed the formulas used by the designer in making the design and presents below the results as he has worked them out. He also has applied the method of analysis and formulas given by Messrs. Taylor and Thompson in their treatise on reinforced concrete, and finally he has made an analysis of his own in what seems to him a rational and simple manner and presents these results for comparison and comment.

The results of the calculations are as follows: (See Table II, p. 69.)

Designer's Method*

Second Floor:

Mean span, 26 ft.

Area of panel, 487 sq.ft.

Dead load, 113 lb. per sq.ft.

Live load, 250 lb. per sq.ft.

Actual load on floor at time of failure equals weight of second floor, third floor and roof, equals 300 lb. per sq.ft.

Thickness of slab, 8 in.

Finished coat of 1 in. applied after slab was cast.

Using the actual load the calculations are as follows:

$$M = \frac{W \times l \times 12}{25} = \frac{300 \times 487 \times 26 \times 12}{25}$$

$$= 1{,}823{,}300 \text{ in.-lb.}$$

$$A_s = \frac{M}{0.88 \times d \times f_s}$$

that is,

$$f_s = \frac{M}{A_s \times 0.88 \times d}$$

$d = 8 - 1.25 = 6.75$ in. for two layers of ½-in. twisted bars (diam. = 0.7 in.);

$A_s = 64 \times 0.25 = 16$ sq.in. for area of all slab bars;

or

$A_s = (16 + 8) \times 0.78 = 22.24$ sq.in. if spider bars are included.

Therefore,

$$f_s = \frac{1{,}823{,}300}{16 \times 5.94} = 19{,}200 \text{ lb. per sq.in.}$$

or

$$f'_s = \frac{1{,}823{,}300}{22.24 \times 5.94} = 13{,}800 \text{ lb. per sq.in.}$$

This method is apparently based on the assumption that the moment over the column supports is only one-half as great as the moment would be if the floor plate were an aggregation of continuous radial beams supported by a single point and all of the reinforcing were concentrated over that point. For the designing dead and live loads these stresses become $f_s = 22{,}400$ and $f'_s = 16{,}100$.

Third Floor:

Dead load, 88 lb.

Live load, 150 lb.

Actual load on this floor at time of failure if falsework had been removed equals weight of third floor and roof and formwork, about 175 lb. per sq.ft. Using actual load the calculations are:

$$M = \frac{175 \times 487 \times 26 \times 12}{25} =$$

1,063,600 in.-lb.

*As explained in previous article, p. 780.

$$f_s = \frac{1{,}063{,}600}{12.25 \times 0.88 \times 5.75} =$$

17,200 lb. per sq.in.

$$f'_s = \frac{1{,}063{,}600}{18.49 \times 5.06} = 11{,}400 \text{ lb. per sq.in.}$$

For the designing dead and live load (238 lb. per sq.ft.) these stresses become f_s = 23,400 and f'_s = 15,500.

Taylor and Thompson's Method

Following the method outlined in the 1911 imprint of the treatise on "Concrete, Plain and Reinforced" (pp. 485 and 518):

Assuming f_s = 16,000 lb. and f_c = 800 lb.)

Second Floor:

r_0 = Radius to line of M (max.) = radius of col. head — 8 in. = 2.25, say 2.3 ft.

r_1 = Radius to line of inflection = $\frac{26 - 4.6}{5} + 2.3 = 6.58$ ft.

Ratio $\frac{r_1}{r_0} = \frac{6.58}{2.3} = 2.86$.

Actual load, 300 lb.

Area of panel, 487 sq.ft.

Area inside line of inflection $\pi x (6.58)^2$ = 136 sq.ft.

Area outside line of inflection = 351 sq.ft.

Load outside line of inflection = 105,300 lb.

Perimeter of line of inflection = 41.3 ft.

Load per ft. on line of inflection = 2550 lb.

r = Radius of col. head, assumed as 3 ft.

Ratio of $\frac{r}{r_0}$ = 1.3.

$M = (300 \times 2.3 \times 2.3 \times 1.25) + (2550 \times 2.3 \times 2) = 13{,}700$ in.-lb. per in.

Following the example and assuming 1⅜% steel is required in the top of the slab,

$$d = \sqrt{\frac{13{,}700}{800}} \times 0.24 = 8.45 \text{ in.}$$

requiring a slab about 9¾ in. thick if ½-in. square twisted bars are used. The total amount of steel required in the top of the slab over the column is

$$A_s = 72 \times 3.14 \times 8.5 \times 0.0137 = 26.4 \text{ sq.in.}$$

The design provided 16 sq.in. in the slab bars and 6.24 sq.in. in the spider bars, or a total of 22.24 sq.in.

Therefore if the method of calculation is correct, the stress in the steel in the design was

$$\frac{26.4 \times 8.45 \times 16{,}000}{16 \times 6.75} = 33{,}000 \text{ lb. per sq.in.}$$

neglecting the spider bars, or

$$\frac{26.4 \times 8.45 \times 16{,}000}{22.24 \times 6.75} = 23{,}700 \text{ lb. per sq.in.}$$

including the spider bars as equally effective, which they cannot be.

Condron's Method

To the author it seems rational to consider the floor plate will deflect and be stressed according to the amount and position of the reinforcement and that the line of inflection will be away from, or close to, the column head, depending upon the resistance to tension offered by the steel bars. From Fig. 2 it will be seen that the position of the steel rapidly approaches the middle of the slab over the edge of the column head. If the steel were kept well up in the top of the slab the line of inflection might be as indicated by x, y, z in Fig. 4, but as it was placed, the line of inflection would probably be more as indicated by t, v, w, in Fig. 4, that is, about 3 ft. on the diagonal beyond the column head. Assuming that such is the probable condition and that all of the tension due to negative moment must be taken by the steel in the top of the slab, is it not reasonable to consider that the loaded area f, g, h, v, f, is supported on the line t, v, 2 and balanced by a similar load on the opposite side of the column, producing a more or less uniform bending moment on the edge of the column head k, m, n? In Fig. 4 only the diagonal bands are shown, as the other bands are entirely in the bottom of the slab and can only assist by being put in compression at the column heads.

Second Floor:

On this basis the moment and stresses may be calculated thus for the second floor:

Total area of panel = 487 sq.ft.

Area inside line of inflection t, v, w, = 100 sq.ft.

Area outside line of inflection = 387 sq.ft.

Load at time of failure = 300 lb. per sq.ft.

$M = 300 \times 387 \times 3 + 300 \times 75 \times 1.5 = 382{,}050$ ft.-lb.

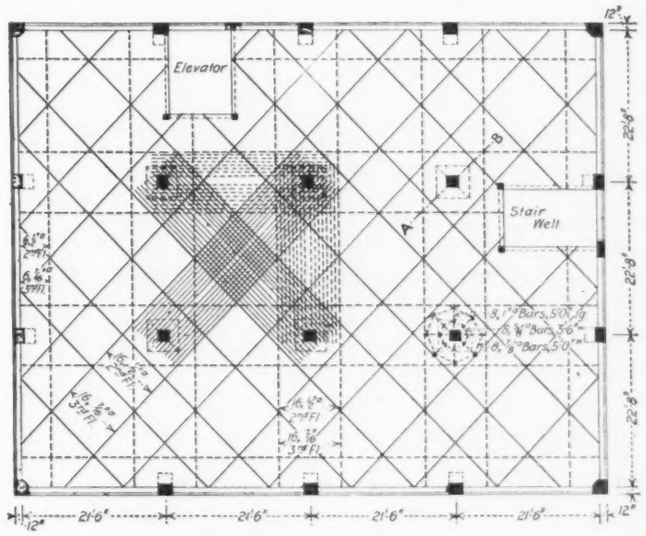


Fig. 1 Typical Floor Plan

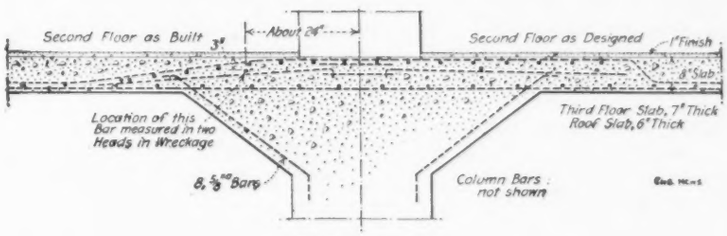

Second Floor as Built
About 24"
Second Floor as Designed
1" Finish
8" Slab
Third Floor Slab, 7" Thick
Roof Slab, 6" Thick
Location of this Bar measured in two Heads in Wreckage
Column Bars not shown

Fig. 2 Section A-B Enlarged

FIGS. 1. AND 2. TYPICAL FLOOR PLAN AND SECTION THROUGH COLUMN, SHOWING COLUMN HEAD AS DESIGNED AND AS BUILT

(Reproduced from Engineering News, Dec. 28, 1911, p. 780.)

Note—Fig. 3 of first article, showing the temperature record during construction, not reproduced.

$$f_s = \frac{M}{A_s \times 0.86d} = \frac{382{,}050 \times 12}{92.8} =$$

49,440 lb. per sq.in.

that is, neglecting the spider bars; or, including the spider bars, the stress in the steel is

$$f'_s = \frac{382{,}050 \times 12}{129} = 35{,}520 \text{ lb. per sq.in.}$$

The maximum positive moment between the columns will be resisted by all of the bars in the bottom of the slab and this moment may be calculated as

$\frac{WL}{12}$, where W is the total load outside of the line of inflection and L is the mean span between these lines of inflection. The writer would in his practice take this moment as $\frac{WL}{8}$, but that may be considered over-conservative, so it is here taken as the lesser amount. The mean span is taken as 18 ft.; therefore

$$M = \frac{300 \times 387 \times 18 \times 12}{12} = 2{,}090{,}000 \text{ in.-lb.}$$

$$f_s = \frac{M}{16 \times 0.86 \times 6.75} = \frac{2{,}090{,}000}{92.88} = 22{,}500 \text{ lb. per sq.in.}$$

For the designing loads these stresses would be greater than the above in the ratio of $\frac{350}{300}$ or for the steel over the column the stress would be 41,500 lb. and between the columns 26,300 lb. per sq.in.

Third Floor:

Applying the writer's method to the design of the third floor, the computations and results are as follows, first for the designing load of dead and live loads equal 238 lb. per sq.ft. total; and second for the probable load at failure of 175 lb. per sq.ft.:

For

$W = 238$ lb. per sq.ft.

$M = 238 \times 387 \times 3 + 238 \times 75 \times 1.5 = 303{,}093$ ft.-lb.

$$f_s = \frac{M \times 12}{18.5 \times 0.86 \times 5.75} = 39{,}700 \text{ lb. per sq.in.}$$

over the columns.

For

$W = 175$ lb. per sq.ft.

$$f_s = \frac{175}{238} \times 39{,}700 = 29{,}200 \text{ lb. per sq.in.}$$

over the columns.

The moments and stresses between the columns are, for the 238-lb. load:

$$M = \frac{238 \times 387 \times 18 \times 12}{12} = 1{,}657{,}900 \text{ in.-lb.}$$

$$f_s = \frac{1{,}657{,}900}{12.25 \times 0.86 \times 5.75} = 27{,}300 \text{ lb. per sq.in.}$$

between columns.

For

$W = 175$ lb. per sq.ft.

$$f_s = \frac{175}{238} \times 27{,}300 = 20{,}000 \text{ lb. per sq.in.}$$

between columns.

The results of these three methods of calculations are brought together in Table II. It will be observed how great is the variation of the stresses determined by these three different methods. The designer's method is not based upon any particular analysis, so far as the writer is aware. Taylor and Thompson's method is based upon a simple analysis, except that it introduces certain constants derived from Poisson's ratio, with which the writer claims no familiarity and may not have succeeded in correctly selecting and interpolating the proper constants from the authors' published tables, in which case his results may be much in error. Here is an illustration of the danger of using formulas that are not well understood by the user. The writer's method is at least devoid of complications and seems to him to be reasonable. It simply assumes that, for floors of this type, where the bars are carried near the top of the slab over the column head and allowed to droop to the bottom of the slab, there is a line of inflection surrounding each interior column, and that this line incloses an area equal to approximately one-fifth of the panel area. The remainder of the panel area is supported on this line of inflection and, therefore, the total moment around the column cap is equal, $M = W$ [⅘ panel area × distance from the edge of column cap to the line of inflection + (⅕ panel area — area of column cap) × one-half the distance from the edge of the column cap to the line of inflection] where W equals the dead plus live load per sq.ft. With all dimensions in feet, M will be in foot-pounds; therefore the stress in the steel will be,

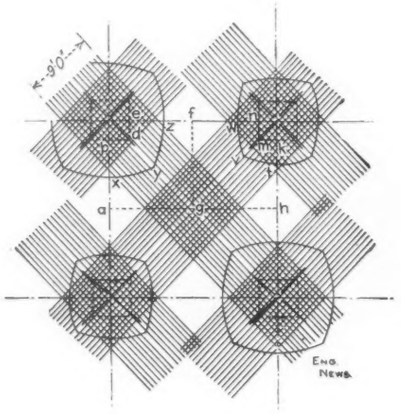


FIG. 4. TYPICAL PANEL OF FLOOR OF PREST-O-LITE BUILDING

$$f_s = \frac{M \times 12}{A \times 0.86d}$$

where A equals the total area of bar sections in the top of the slab cut by a circle somewhat larger than the perimeter of the column head, and d equals the effective depth and will therefore be the distance from the bottom of the slab to the center of gravity of the steel directly above the edge of the column cap. For two layers of bars d will be between 1 and 2 in. less than the depth of the slab. For four layers of bars d will be from 1½ to 3 in. less than the thickness of the slab. Where "spider bars" are included in the effective section, the center of gravity of the reinforcing will be materially lower than where they are not included.

This method of analysis, if applied to the design of the floors of the Deere and Webber Building, Minneapolis, the test of which was described by Mr. Arthur R. Lord in a paper before the National Association of Cement Users in December, 1910 (see ENGINEERING NEWS, Dec. 22, 1910), gives a stress in the steel that agrees very closely with the stresses measured by Mr. Lord. These stresses in the steel when the floor was carrying its designed live load, of 225 lb. per sq.ft. were recorded by Mr. Lord as, maximum, 20,700 lb., and average, 16,500 lb. per sq.in. in the diagonal bars. The analysis of this floor is as follows:

Deere & Webber Building by Condron's method:

Column spacing, 19 ft. 1 in. by 18 ft. 8 in.

Slab thickness, 9.2 in.

$d = 7$ in.

Reinforcement over col. head, { 52 ⅝-in. bars / 4 1¼-in. bars } Total section = 25.4 sq.in.

Diameter of col. head, 4 ft. 6 in.

Diameter of line of inflection, 9 ft. 6 in.

Area of panel, 356 sq.ft.

Area inside line of inflection, 71 sq.ft.

Area outside line of inflection, 285 sq.ft.

Area over col. head, 16 sq.ft.

Dead load, 115 lb.; live load, 225 lb.; total, 340 lb. per sq.ft.

$M = 340 \times 285 \times 2.5 + 340 \times 55 \times 1.25 = 265{,}625$ ft.-lb.

$$f_s = \frac{265{,}625 \times 12}{25.4 \times 0.76d} = 21{,}000 \text{ lb. per sq.in.}$$

It is interesting, in view of Mr. Lord's report, to analyze the design of the Deere & Webber Building by Mr. Baker's method as follows:

$$M = \frac{W \times 1 \times 12}{25} = \frac{340 \times 356 \times 23 \times 12}{25} = 1{,}317{,}844 \text{ in.-lb.}$$

$$f_s = \frac{M}{A_s \times 0.88d} = \frac{1{,}317{,}844}{25.4 \times 0.88 \times 7.7} = 7630 \text{ lb. per sq.in.}$$

or

$$A_s = \frac{M}{0.88 \times d \times 16{,}000} = 12.16 \text{ sq.in.}$$

Therefore, according to Mr. Baker's method, if correctly understood by the writer, he would have provided about one-half as much reinforcement over the column heads as was actually used by the builders, or he would have greatly reduced the thickness of the slab. The test as reported by Mr. Lord indicates that all of the steel used was actually required.

The formwork used by the contractors on the Prest-O-Lite building, is shown by Figs. 5 and 6, reproduced from sketches furnished the writer by Mr. Herbert Foltz, architect for the building. This formwork was amply strong if built and braced as shown, but the detail of the support of the 2x10-in. girders on edge on top of 4x4-in. posts with a "scab" on one side only is not good construction, as it is lacking in stability. Especially

would this be true if the scabs were all put on the same side of a 2x10-in. girder, in which case a very slight disturbance of the supports, such as knocking off of some of the braces, would be liable to cause the posts to "kick" out from under a girder and let a section of the forms drop, thus bringing on failure to an unlimited area of the formwork.

Conclusions

All observers of the wreckage of this building seem to agree that the concrete of the second floor had set and attained its normal strength, while the concrete of the third floor had not set and was little better than loose sand and gravel. As the concrete of the roof was still soft and wet, it is therefore evident that the failure did not result from faulty design of the third floor or roof. If the falsework above the second floor was weak or was disturbed, that might account for the collapse. If the second floor itself, which was finished and had its forms removed, was not strong enough to carry the weight of the third floor and roof, then the weakness of that floor may account for the initial giving away which brought on the general collapse.

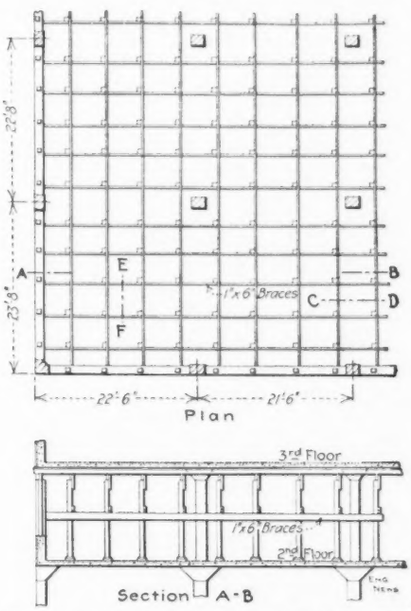


Fig. 5. General Layout of Falsework Support for Floor Slab

From the appearance of the ruin, as stated by an engineer who examined the wreck a few hours after the collapse, the initial failure was in the interior panel to the right of the center on the plan, Fig. 1. At this location the falsework posts remained in a nearly vertical position, as if the floor supporting them had collapsed and let the structure above go down as through a funnel. It is possible that a greater weight of roofing cinders was collected above this panel than elsewhere and so contributed to the failure.

From all that the writer has been able to gather relative to this collapse and the analysis he has attempted to make of the design of a typical interior panel, without considering whether the floor construction along the walls was or was not as strong as the interior panels, he concludes:

First: That the weight of the third floor and roof, together with the formwork, rested on the second floor and seriously overstressed that floor, although this load was less than the load it was supposed to be designed for. It is stated that in each panel of 487 sq.ft. there was one 4x4-in. unbraced post under the center and one between each pair of columns, which would be capable of carrying safely about one-sixth of the weight on this panel. The stress in the steel of 35,500 lb. per sq.in., as calculated by the writer, would mean that the concrete was stressed nearly up to its ultimate compression strength, considering the age of the concrete; but in view of the fact that so large a proportion of the reinforcement over the column head was in the "spider bars," which extended only about two feet beyond the column head and were located near the center of the slab, the writer is of the opinion that the slab bars were actually stressed beyond their elastic limit and gradually stretched, thus increasing more and more the compression and diagonal tension in the concrete, and breaking the bond between the concrete and the steel, until, finally, the relatively short embedment of the slab bars over the head was unable to hold these bars and an entire panel of the floor gave away, carrying down with it the formwork and the unseasoned concrete above, bringing on the general collapse of the entire building. Probably a greater weight was brought upon one panel than upon the other by a pile of cinders on the roof. The appearance of the wreck bears out this theory for the bars in places were stripped clean from the concrete over the column heads, except for the "spider bars" which were stripped out of the slabs and remained in the column heads. No bars were broken so far as the writer knows. In testing reinforced-concrete beams to destruction the bars stretch but do not break; the concrete fails with the stretching of the bars beyond their elastic limit.

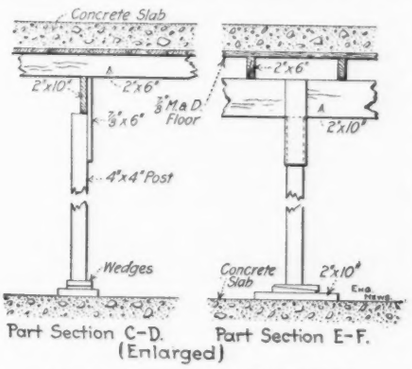


Fig. 6. Details of Falsework

Second: If notwithstanding what the writer believes was the seriously overstressed condition of the second floor, that floor was able to carry its load, then the only other explanation of the failure that he can offer is a failure of the falsework, which, as has been explained, could easily have resulted from knocking off some of the bracing and so shaking or disturbing some of the posts that they "kicked" out from under one of the 2x10-in. girders, which, as shown, were supported in a rather unstable manner.

Third: The concrete materials for the third floor should have been well heated before they were mixed and placed on Nov. 11, notwithstanding the warmth of the day, because ample warning was given that a sudden and a great drop in temperature was due that night and moreover unusual care should have been taken to prevent the third-floor concrete from freezing after it was in place. Had this concrete not frozen the third floor would doubtless have been strong enough to carry its own weight and possibly the weight of the roof and falsework, provided there was sufficient cement of good quality used.

Fourth: As shocking as this disaster is, it would have been even worse had the structure held together until it was completed and occupied and then collapsed under loads of moving machinery, when filled with a large number of employees.

TABLE II. STRESSES IN STEEL OVER COLUMNS IN THREE FLAT-SLAB FLOORS‡

[Considering the "spider bars" as fully effective*]

Stresses in pounds per square inch according to	Presto-O-Lite Building, Indianapolis: Second floor, Design load 350 lb. per sq.ft.	Presto-O-Lite Building, Indianapolis: Second floor, Probable load 300 lb. per sq.ft.	Presto-O-Lite Building, Indianapolis: Third floor, Design load 238 lb. per sq.ft.	Presto-O-Lite Building, Indianapolis: Third floor, Probable load 175 lb. per sq.ft.	Deere & Webber Building, Minneapolis, Design load 340 lb. per sq.ft.
Baker†	16,100	13,800	15,500	11,400	7,630
Taylor and Thompson	27,700	23,700	26,500	19,500	.....
Condron	41,500	35,500	39,700	29,200	21,000
Tests by Lord	.....	.....	.....	.....	Max. 20,700; Av. 16,500

*Owing to the "spider bars" being much lower in the slab and extending only 5 ft. from the column centers, these bars should not be calculated as supplying equally effective section as the slab bars over the column head. In the second floor these bars furnish 28%, in the third floor 33⅓% of the calculated area of steel. In the Deere & Webber building, the "spider bars" furnish 38½% of the calculated area, but they extend farther into the slab.

†Mr. H. J. Baker, designer of the Presto-O-Lite floors.

‡Table I appeared in Engineering News, Dec. 28, 1911.

The Lessons Taught

The lessons to be learned from this failure are that designs offered in competition should be checked by a competent engineer retained by the owner or architect and should always be such as can be analyzed for stresses by methods that are clearly understood, or so well proved by tests that no doubts may arise as to their safety; that danger attends the practice of letting contracts for buildings based on alternate designs, the main object of which is to use less materials than other contractors have estimated on, or are willing to take risks with, that no matter how honest and conscientious the contractor is, the owner should have all structural work, whether of wood, steel or reinforced concrete superintended or inspected by a competent and experienced man who will view the work from the owner's standpoint; that contractors should exercise greatest care in planning, building, and removing formwork and staging, so as to make it certain that it will serve its purpose for, after all, the contractor is the one to suffer from disasters during construction; that concrete should not be mixed and placed when the temperature is below 45° F. without at least heating the water used and being certain that the concrete materials are free from frost. (It is safer to heat all of the materials so that the wet concrete will have a temperature of at least 70° F., thus insuring rapid setting and security against injury by subsequent freezing); that while hundreds of reinforced-concrete structures are going up at this time all over our country and the numbers of accidents or failures therewith are surprisingly small, this particular failure should be so well studied by all engaged in reinforced-concrete building work that no more such disasters will happen in connection with such construction in this country.

Specifications for Fire Hydrants of the post type will be submitted to the meeting of the New England Water Works Association to be held in Boston on Jan. 10. The specifications are in the nature of a final report of the committee appointed by the Association some time ago, consisting of H. O. Lacount (chairman), engineer, inspection department, Associated Factory Mutual Fire Insurance Cos, Boston, Mass.; George A. Stacy, superintendent, waterworks, Marlboro, Mass.; Frank A. McInnes, Public Works Department, Boston, Mass.; Fred W. Gow, water commissioner, Medford, Mass., and William F. Sullivan, engineer and superintendent, Pennichuck Water-Works, Nashua, N. H. Those interested in the subject can doubtless obtain advance copy of the proposed specifications by sending a 2c. postage stamp to the Association named, at Tremont Temple, Boston, Mass. Discussion of the specifications is solicited by all who are interested in the subject. Those who cannot be present at the meeting are urged to send written discussions to the editor of the Journal of the New England Water Works Association.

Irrigation Finance*

By N. E. Webster, Jr.†

Classifying broadly, there are three conditions which must be met in order to make a proposed scheme of irrigation a success: (1) An available supply of unappropriated water so situated that it may be carried to cultivable lands which are not available for agriculture except by the artificial application of water; (2) a practical engineering plan for the carriage of the water to the land and distribution thereon, making reasonably sure that the system may be relied upon as permanent; and (3) capital sufficient to complete the undertaking, with assurance of ultimate return with interest for the period during which it has been tied up, and with additional profits to properly compensate such capital for the risks taken.

The large irrigation developments have been financed almost exclusively by bond issues. The men who have acquired control of the necessary land and water have invested some money in engineering surveys and designs, and often in some development work. When the project seemed reasonably well assured, a corporation has been organized to take over the proposition. For the actual cash expenditures made by the original developers they have frequently been paid in bonds or in cash derived from the sale of bonds. For the intangible assets it has been often the practice to issue all of the capital stock; these assets often consist of the control of the water and through it of the land, by means of water appropriations which, while not perfected and vested, are temporarily good and susceptible of being perfected. Thereafter the project has no means for raising money other than by sales of bonds, until it shall have reached the stage when it can begin to realize on the sale of land or water rights or both.

Up to the time of the bond issue the expenditures have been (1) for preliminary surveys, designs and estimates; (2) for organization and promotion expenses, and (3) for the acquisition of lands and existing irrigation systems. After the time of the bond issue the expenditures will be (1) for the final engineering, including topographic and location surveys and structural design; (2) for actual construction; (3) for general administrative and legal expense; (4) for one or two years' expense of operation and maintenance; and (5) for interest on the bond issue.

We have the published reports of the U. S. Reclamation Service covering over 30 projects throughout the entire arid region. While the form of these reports is not that best suited for projects developed by private capital, a study of the figures seems to warrant these conclusions: (1) The expense of organization and promotion together with the reimbursement of original promoters for their cash disbursements may be estimated at 10% of the cost of construction; (2) the general administrative expense during the construction period may be estimated also at 10% of the cost of construction.

The duration of the construction period, counting from the organization of the company, may be estimated at from two to five years. The additional time after the completion of the construction work for the delivery of water before collections can be counted upon as a reliable income will average two years. And as the money for construction must be provided in advance of expenditure requirements, an additional six months must be counted upon after bond sales before the funds are disbursed. These three elements of time indicate that the interest charges on the bonds during the construction period and two years of the operating period would (at 6%) amount to from 21 to 30% of the construction cost. I have measured these items of expense in terms of construction cost because there is usually an engineering estimate of the construction cost, while there may be no estimate of the total cost including all other expense items.

From these figures we find that the three items of initial organization expense, general expense during construction, and bond interest together entail an outlay of from 41 to 50% of the construction cost. Moreover, it should be noted that the interest charges as here computed are only on the money necessary for construction. So that if the cash for all purposes is to be provided from the bond issue, the total issue must at a minimum exceed the actual cost of engineering and construction by from 50 to 65%, according to whether the project will require from two to five years for building. These figures are based upon the sale of bonds at par. If they net the company less, the amount of the discounts and commissions must be provided for by an increase of the foregoing excess over construction cost.

Let us examine the security to be put behind the bonds. The trust deeds usually mortgage all of the company's property, real and personal (both presently owned or thereafter acquired); as collateral they require the deposit of contracts for the sale of land or water rights (or both) to the extent of 125 to 150% of the amount of bonds issued. This additional security is sometimes waived as to a portion of the issue.

These two classes of security are mutually exclusive, for to the extent that each water-right contract disposes of a portion of the entire supply available for sale it reduces the equity of the company in

*Abstract of a paper read before the National Irrigation Congress, held at Chicago, on Dec. 5 to 9.

†Niles & Niles, certified public accountants, 111 Broadway, New York, N. Y.

the physical property which it has produced. In the final analysis, the lien which the water-right contract gives on the land and water is the stronger security, but until the project is well along toward completion there is no assurance that this security will ever be perfected by providing the water which will give the land its possible value. Pending the time when completion is assured, the security rests wholly or mainly on the value of the property mortgaged, rather than on the land to be irrigated.

But if the funds for all purposes are derived from the bond issue, then (as we have seen) the other expenses, not including bond discounts and commissions, will require from 50 to 65% of that required for construction. So that of the entire proceeds of such bond issues only 66.6 to 60% will be available for actual building operations. Such an investment in tangible property does not offer a real security for the bonds, the safety of which then rests on the successful completion of the enterprise. They then lose the element of security which should be a prerequisite for a bond, and become preferred speculative investments in the whole project. And yet there is no way to improve the security behind the irrigation bond during the construction period unless provision can be made whereby these general expenses (and especially the bond interest) are provided for otherwise than from the sales of bonds.

How, then, shall irrigation projects be financed in order that they can carry interest and general expense until water-right contract collections are supplying an income sufficient to provide for such interest charges and a sinking fund for the bonds? (1) By a bond issue the proceeds of which shall be sufficient to provide for all construction and engineering, and for the purchase of lands and existing irrigation systems, and shall be restricted to such uses. (2) By a preferred stock issue, the proceeds of which shall be sufficient to provide for the promotion and organization disbursements, the general administrative and legal expenses during construction, and the bond interest until the latter is supplied from water-right contract collections. (3) By a common stock issue for the intangible assets acquired from the original promoters.

By this method the bonds will at all times have as security construction work and available cash equal to 100% of the bond proceeds. The water-right contracts deposited as collateral will be a better security than now, as the investment by the preferred stockholders will give increased likelihood of the efficient and speedy completion of the construction work. The preferred stock should be preferred as to assets, and guaranteed a fair return for the period of its investment and might properly be subject to retirement under prescribed conditions after the collections were sufficient to provide both interest and sinking fund for the bonds.

When thus retired the further profits of the undertaking would (as now) belong to the common stock. The plan herein proposed does not at all affect the status of the present stock. It does, however, distinguish between the investment and speculative features of the present irrigation bond by providing that the speculative element shall be assumed by the preferred stock, thus leaving the bond with a security whereby it could well be styled an investment proposition.

A Riveted Steel Water-works Intake has been in use at Muskegon, Mich., for 20 years. It is thus described in a report on the city named, published in December, 1911, by the Committee on Fire Prevention, of the National Board of Fire Underwriters (135 William St., New York City):

A 30-in. line of riveted steel pipe, 3970 ft. in length, laid in 1892, extends from a submerged rock-filled timber crib and connects through 24-in. branches to two suction wells located 84 ft. from the pumping station. Inlet end is upturned and covered by perforated steel plate; water depth, 40 ft.; plate 32 ft. below surface; pipe is laid in trench, with sand covering; outlet end at suction wells, 7 ft. below lake level. An emergency connection to the line, of similar construction, of 900 ft. of 24-in. pipe, is provided.

Considerable trouble has been experienced from sand. In 1910, the trouble becoming serious, an examination was made of the outer crib; the rock protection had disappeared and sand had collected and was washing over the plate; the sand was removed and the rock replaced, but the trouble continued. In March, 1911, pipe was found broken, in one place the pipe ends being about 40 ft. apart, and in another the pipe being sheared; the breaches were repaired, but considerable trouble is still experienced; physical condition of pipe was found to be excellent.

Letters to the Editor

Can the Independent Compete with the Trusts?

Sir—Having already trespassed too heavily upon your courtesy, in discussing the offer of free engineering service by government bureaus, I should now keep silence if the hopelessness of your case had not driven you to misrepresent me as failing to recognize that "somebody has to pay the cost of performing that service," notwithstanding that, in my letter published Dec. 7, I specifically admitted "that the 90,000,000 people of the United States will be taxed possibly an additional cent or two apiece."

You now tell us that "the great railway corporations . . . have found by experience that they can buy cars and locomotives and a hundred different supplies far cheaper than they can produce them for themselves."

In so far as this is true, it merely reminds us that the concern which attacks a specialty with a large organization can out-compete the smaller producer in that same line (in this case, the railway company).

In this connection, it is interesting and gratifying to read, on p. 777 of your current issue, that ENGINEERING NEWS has now grown big enough to do its own printing.

You mention "a long list of industrial trusts which have gone to the wall because they could not meet the competition of small independent well managed rivals." How much longer is the list of small concerns which have been driven or kept out of business, or absorbed, by great corporations?

You say, "We have at no time admitted that the individual engineer had no chance against the competition of the Roads Office." I quote from your remarks in your issue of Dec. 7, "What possible chance has a bridge engineer to earn a living by the independent practice of his profession, if the United States Government steps in to compete with him and offers to do his work gratis?"

But, since you have now concluded that "the individual engineer would win, hands down," what becomes of your solicitude, of Nov. 16, on his account?

JOHN C. TRAUTWINE, JR.,
257 S. 4th St., Philadelphia, Penn.
Dec. 29, 1911.

[Perhaps in the comment which our correspondent quotes above, we did not sufficiently emphasize the word *gratis*.

To bring out this idea we will back Mr. Trautwine to continue to publish his pocketbook profitably in the face of the competition of the United States Government, provided the Government charges the purchasers of pocketbooks the full cost of compilation, editing, printing, etc. But when the Government gives pocketbooks away, Mr. Trautwine will have no fair chance.ED.]

The Appointment of Engineers to Executive Positions

Sir—Your editorial comment upon the recent action taken by the Brooklyn Engineers' Club has been read by me with great interest, and I have heard it favorably commented on from all sides. The statement of the case made is so complete and convincing as to leave little remaining to be said.

Both Public Service Commissioners Cram and Eustis may be pardoned for the expressions of opinion voiced by them, since they are very nearly those held by men of affairs in political and business positions generally. But, that this opinion is so generally held among those outside the engineering profession is largely the fault of engineers themselves.

It is very true that because a man is an engineer, he is not necessarily qualified to fill positions of executive, administrative, or judicial scope; neither is it so, that because a man is a lawyer or has had experience in active business affairs, he is fitted for such a positon. The successful selection will depend largely upon the qualifications of the man himself, independent of his particular learning and training.

It must be admitted, however, that all things being equal, in the exercise of judicial and administrative functions largely on engineering matters, one who has had both experience and training in engineering matters would be more desirable than an individual whose experience and attainments have been entirely as a medical practitioner. This may be considered an extreme case, but I have purposely avoided a comparison with a legal practitioner, since the public is so generally of the opinion that the practice of law qualifies the individual for any and all duties thereafter, whether in the legal branch or otherwise.

It can hardly be held that the lawyer necessarily at the outset of his career, when solely learned in the intricacies of the common law, statutes, mode of procedure, etc., is a man who has a broad outlook on things. Is he not rather the same as Commissioner Cram's engineer, a man whose vision has been warped and narrowed by constant attention to details?

It is very true that the practice of law as applied in many of the states of the Union affords opportunities for embracing a comprehension of business from the bottom up and from the top down. This is undoubtedly a result of the fact that all fields are open to the legal mind, not necessarily because they are legal pursuits, but on account of the strong and aggressive stand taken by that profession, individually and collectively, through its bar associations, in furthering an *espirit de corps* and insisting that it be reckoned with in the nomination, appointment, and selection to office and the conduct of business affairs. Perhaps a similar aggressive stand on the part of engineers, individually and collectively, might give a similar result.

Certainly the engineering profession has pleaded guilty to the accusation that it does not possess executive, administrative or business ability, since one would naturally infer that if the profession as a whole possessed these qualities, it would not willingly and passively submit to the subordinate and subservient place so often reserved for it. It must be freely admitted that in the selection of those who honor the judicial bench, the claims of the legal profession are preëminent, since the interpretation of the law and decisions in connection with legal matters, are admittedly problems for the mind trained in legal lore.

However, it does not follow from this that the claims of the legal profession should extend to practically all other public offices, and, in fact, to the direction of corporate and business affairs. Quite the contrary. A line of reasoning that would admittedly bestow upon the legal profession the sole control of judicial position, would in the same way, accord to the engineering profession the control, direction, and execution of the public offices having to do with public works, and administrative and executive work closely allied with construction of public improvements, even as would the direction of hygiene and the public health be preferably under the direction of those of the medical profession.

The very high place attained by the law outside of strictly legal lines can partially be attributed to the success of a lawyer in pleading his own cause; since the successful practice of law among the leaders in the profession is, of necessity, dependent upon the ability with which the cause of others can be pleaded, it is but natural that in turn, an individual should become skilled in pleading his own cause, not alone for consideration in a strictly legal line, but in other lines. This, to some extent, will account for the consideration given to this profession by the public in general.

An engineer, unfortunately, is not so skilled. In his professional work he has been taught to believe that the results obtained by him speak for themselves and need no special pleading. A bridge successfully constructed in itself demonstrates the fitness and ability of its designer and constructor, as an engineer.

Perhaps we will soon come to the time when the ability to express thoughts in writing or orally will also be an accomplishment of the engineering profession, so that it may not alone do the strictly technical work required of it, but also impress upon the public mind by written and spoken words the excellence of its attainments and the plea that it be accorded consideration in the inception, direction, execution and administration of affairs which have as their principal and almost sole object the successful accomplishment of public works.

Lawyers have frequently been heard to make the remark that as those learned in the law, they were best fitted to make laws, and they have certainly carried out the threat, although the decisions and counter-decisions that are handed down from various courts as to the interpretation of those learned laws would seem to show that they might have been expressed more clearly and their intention not clouded beyond recognition.

Engineers have been heard to make the statement in connection with the making of building codes and ordinances as affecting city work, that they were best fitted to frame such ordinances and codes. The results would seem to demonstrate that the assertion had not been made with sufficient emphasis, nor had it enlisted the support of public or political opinion.

There is undoubtedly a great opportunity for engineers to be accorded more consideration in the future, but this will only be accorded through initiative on the part of the individual and coöperation on the part of the profession as a whole. Our large engineering societies, so long as they assume an attitude of existing solely for the advancement of engineering learning and theory, will be of little help in this issue.

However, the opportunity for them to be helpful as a strong nucleus to teach and mold public opinion, and at the same time aggressively and jealously guard the interests of the profession they represent, can hardly be sufficiently emphasized.

The Brooklyn Engineers' Club has blazed the way in this direction, and while it is doubtful whether its efforts will be crowned with any success, its example, if it succeeds in stimulating other organizations of a similar character, will have done more than its intentions in the particular question at issue. It has, at least, demonstrated that among its members there must be a few who have the qualities of successful administrative, executive ability, and business acumen.

Doubtless, in spite of the learned argument to the contrary, when other clubs and societies of the engineering profession add their voice to that of the Brooklyn Engineers' Club in a sufficiently emphatic manner, their petitions and suggestions will receive weighty consideration.

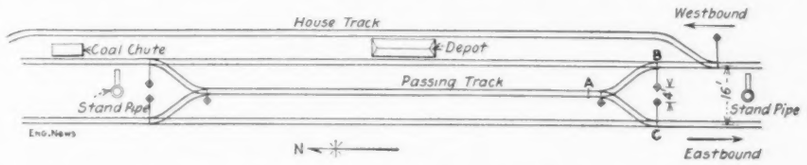
F. R. Harris.

Brooklyn, N. Y., Dec. 29, 1911.

A Wreck Caused by Poorly Placed Switchstands

Sir—On the morning of Oct. 28, Union Pacific passenger train No. 4, westbound, collided with an extra freight train on the passing track at Rock River, Wyo., killing four persons and injuring 17 others. An investigation into the cause of the wreck was made by the railroad's locating and construction engineer, and revealed the conditions to be described.

The eastbound and westbound tracks and sidetracks at the point where the accident occurred are as shown in the figure. At this place the tracks run approximately north and south, and the passing track is located between the eastbound and westbound tracks, connecting with both tracks at both ends. The peculiar location of the yard switches is shown in the figure. The east and westbound tracks are 16 ft. c. to c., and both the switches for the passing track are inside the double track. The distance between the switchstands is 4 ft.



SKETCH MAP OF UNION PACIFIC R.R. YARDS, AT ROCK RIVER, WYO.

When the accident occurred, the extra freight train was standing on the passing track with engine at *A*, bound for the east. Passenger train No. 4, westbound, was coming down the westbound track toward the switch *B* at the rate of 50 miles per hour. The engineer on the freight train gave his brakeman orders to throw switch *C*, so that he could move his train to the eastbound track. The brakeman walked toward switches *B* and *C* and, being a new employee, threw switch *B*, which was only 4 ft. from switch *C*. No. 4 was only 150 yd. away, the quick application of brakes by the engineer was of no avail, and the collision followed.

At the inquest the brakeman claimed that his engineer gave him orders to throw the "westbound" switch *B* and not the "west" switch *C*. It seems apparent, however, that the brakeman, being new to the work, became confused by the approaching train and the close proximity of the two switchstands.

One can fully appreciate the fact that sound engineering judgment would have placed either switchstand *C* or *B*, or better still both of them, on the outside of their respective tracks, making such a blunder impossible. The construction engineer must consider these things, and he cannot be too careful in laying out the yard switchstands in such a way as to leave no doubt as to which to throw at the proper time.

If we imagine switch *C* 50 ft. south of switch *B*, another point must be considered in order to make the train-order and operation system in vogue more complete and efficient. The testimony of the brakeman that he was ordered to throw the "westbound" switch instead of the "west" switch, shows another weak point, and makes it appear that a better nomenclature could be adopted.

WINFRED L. PROUTY.

Foxpark, Wyo., Nov. 8, 1911.

The Disinfection of Swimming Pools

Sir—The reading of Rettger and Markley's article on the disinfection of swimming pools in your issue of Nov. 23, 1911, recalled a number of ideas on this subject, which have occurred to me during several years past, but which I have never before reduced to writing. A swimming pool being not a necessity but, rather, an expensive luxury whose sole function is to conduce to pleasure and indirectly to health, its value is a minus quantity unless every reasonable effort is made, even at considerable trouble and expense, to reduce to a minimum the possibility of its directly causing sickness and death.

(1) The disinfection of the pool should be continuous (though, of course, it can never be complete) while the pool is in use. It is of advantage to produce in addition occasional complete sterilization between periods of use; but this should never be *substituted* for the continuous process. Any reduction, however slight, in the number of the disease germs in the pool correspondingly reduces the danger of disease; and by *constantly* maintaining *throughout* the pool a low concentration of hypochlorite, the bathers' risk, especially from typhoid, would be reduced to almost nil. Heavier doses (to the point of complete sterilization) at intervals between periods of use give an extra factor of safety; but hypochlorite differs from such antiseptics as phenol and zinc chloride in that in small quantities it does not last long in the presence of organic matter; it quickly kills the bacteria (the intestinal group being fortunately very susceptible) and is then in turn "killed" by the reducing organic substances in the water. Hence in the intervals between applications, unless unduly large quantities are used, the hypochlorite is apt to be reduced below the effective strength, in which case a dangerous concentration of infection may occur, and will then persist undiminished until the next dose.

(2) Second only in importance to continuous disinfection, and greatly facilitating it, is continuous and rapid circulation of the water throughout the pool. A dribble of water, in at one end and out around the upper circumference, does not fulfill the requirements. The water should, for instance, rise vigorously, spring fashion, from a large opening at the bottom of the deep end and sink along the shallow end, the return flow being through a large-caliber pipe or tunnel, the propelling agency being the equivalent of a large-caliber slow-speed rotary pump driven by a small electric motor. Obviously, such a device would turn the water over and thoroughly mix it every few minutes. Live water is much pleasanter to swim in than dead; but the principal advantages would be hygienic, namely: (a) A better aëration of the water, due to the more frequent turning over; and (b), still more important, the more prompt and thorough dilution of any infectious material introduced (in itself sufficient in many cases to reduce the intensity of the infection below the danger point) which, in a sluggish pool would not be accomplished to the same extent within many hours by the mere splashing of the swimmers. Moreover, such a specially produced circulation is almost the only practical method of uniformly distributing any disinfecting substance continuously introduced.

If the construction proposed be considered too expensive, something of the same effect could be accomplished at less initial expense, though less efficiently, by the use of a number of small motor-driven screw propellers, properly guarded, arranged at intervals around the upper circumference of the pool.

(3) Not strictly relevant to the original subject, but fitting well with it, is the idea of substituting, for the fresh water of the pool, an isotonic or physiologic salt solution, the simplest form of which is 0.85% solution of sodium chloride in water. This fluid is far less irritating to the mucous membranes of the eyes, ears, and respiratory passages, than is either pure water or any other concentration of brine, and for this reason is less apt to predispose to infection. Again, it serves to a considerable extent to disguise the taste of the hypochlorite; and, moreover, the hypochlorite might be directly produced from the sodium chloride in the water by electrolysis, the dosage being regulated at will by using more or less current.

It may be found advantageous to add other substances to the water, such, for instance, as borax, sodium bicarbonate, etc. A minute trace of ammonia in the water is said to increase many fold the

disinfecting power of the hypochlorite (Rideal).

It would appear, then, that considerable improvement can be effected in the agreeable qualities and hygienic conditions of swimming pools, by using an improved fluid, by keeping it thoroughly mixed, and by subjecting it continuously to some process or processes that will reduce the intensity of any serious infection that may occur, especially as to the unforeseeable and usually unnoticed maxima of infection.

(a) Heat efficiently destroys all pathogens important in this connection (including the tubercle bacillus, which resists concentrated hypochlorite), but has the disadvantage that its action is strictly localized to the water actually passing through the heater. But it may be had, practically for nothing, by the use of the Forbes or other regenerative sterilizer. That is to say, during most of the year in this climate the water must have heat continually added to it to keep it at the proper temperature. This is usually effected by heating the incoming water a few degrees. Water sterilized in an efficient regenerative apparatus is, at the end of the process, only 2 to 10° F. hotter than at the beginning; the sterilization thus being a by-product of the necessary heating of the water.

(b) Under certain circumstances it would be practicable to pass ozonized air through the water. Or the water might be subjected to ultra violet light from suitable screened and guarded mercury lamps placed in a rapid current in the pool. The incidental illumination of the water could be made to produce striking esthetic effects.

(c) However, these methods (a and b) are not so applicable to the reduction of infection in pools subject to constant reinfection as they are to the disinfection of currents the whole of which pass through a particular limited space, being infected before, thoroughly disinfected at, and not reinfected after. The exact converse is true with respect to chemical disinfectants, especially hypochlorite, which, when put into a portion of a body of water, renders it actively, though transiently, germicidal; so that when mixed with the remainder of the water disinfection occurs throughout the mass. Hypochlorite has the further advantage that it destroys organic matter, greatly prolonging the period of usefulness of a given quantity of the water and making constant replacement unnecessary. Moreover, when not used in excess, it spares many of the harmless and beneficial saprophytes or even favors their growth by destroying their competitors; thus, especially in conjunction with the forced circulation, promoting the natural oxidation of the organic matter in the water.

If prevention were *completely* practicable, no form of disinfection would be necessary. Prevention can, of course, greatly reduce the amount of infection introduced into the pool, especially at the maxima. Suppose, however, the case of an unrecognized typhoid-bacillus carrier who accidentally or as a result of habit (acquired by many boys in the country) allows a quantity of highly infectious urine to contaminate the pool. To provide for such by no means an improbable occurrence, it would be the part of wisdom to keep the pool as highly charged with hypochlorite as would not discommode the swimmers; this being facilitated, as before stated, by the use of isotonic salt solution.

While the use of antiseptics in *food* is to be condemned, the occasional incidental application of hypochlorite, in small quantities and high dilutions, to the mucous membranes, could not be other than beneficial.

The custodian of every swimming pool should be trained to perform a few of the most significant and easily conducted of the methods of determining the chemical and bacteriological composition of the water. For example, the presumptive colon test should be made (quantitatively by dilution) every few hours, unless for some reason the pool is known to be above suspicion; likewise a (colorimetric?) determination of the hypochlorite content, any sudden drop in which would call for an increased supply, and would also indicate unusual contamination, as by urea. However, it is not improbable that after extended trial and progressive improvement, some process will be found so efficacious as not to need this constant watching.

In the meantime this increased attention to the swimming pools would not necessitate any unreasonable effort or expenditure. Educational institutions, especially, should look into the matter, both as an interesting field for research and as a necessary item in the care for the physical welfare of their students.

NORMAN ROBERTS,
Passed Assistant Surgeon,
U. S. Public Health and Marine-Hospital Service.
Hygienic Laboratory,
Washington, D. C., Dec. 21, 1911.

Borrow Pits in Levee Building; Should They Be Made on the River Side or the Land Side?

Sir—In the article written by Mr. H. T. Cory, M. Am. Soc. C. E., in your issue of Dec. 7, 1911, concerning the work along the Lower Colorado River, he says, on p. 671:

> In building the "C. D. Co.'s" levees, fear of just such results caused the adoption of the heroic alternative of making the borrow pits on the land side only, and every possible precaution was taken not to disturb in any way the natural vegetation on the river side of the levee.

And in his reply on p. 673, Mr. Ockerson, who did the work criticized, says:

> The first closure made by the Southern Pacific Co. failed shortly after its completion, and it is well known that the prime cause of failure was the lack of a muck ditch, proper preparation of the foundation, and a continuous borrow pit on the land side. The writer examined the situation s' ortly after the break and was then and still is of the opinion that the chief cause of disaster was the borrow pit on the land side.

The failure of the Southern Pacific levee followed as a natural result of building the levee on a foundation full of long drying cracks reaching several feet in depth and through the foundation with no cut-off wall, or watertight "muck ditch" intervening, through which cracks and porous earth water passed in large volume, in the aggregate.

In order that a scouring current shall be produced in the "borrow pit on the land side of the levee," there must be a stream of water; and if water be passed through the levee in sufficient volume to attack it by means of the current along the borrow pit in the rear, the levee has already failed or is in process of dissolution. Anyway, the slopes of borrow pits for a given levee, whether in front or rear, are probably nearly identical, and the scouring current along the borrow pits will more certainly and inevitably arise if the slope is sufficient and wash away the levee if the borrow pits are on the water side of the levee, than if on the land side, if no traverses sufficiently high to control the currents are made in either case.

The United States Government began levee construction on the Mississippi River after the disastrous flood of 1882, under specifications for the work prepared by a Board of Engineer Officers of the Army, of which board the writer was junior member and recorder.

In preparing the specifications, the most experienced levee engineers of Mississippi, Louisiana and Arkansas were consulted upon every feature, including that requirement which has never been changed, that the material when practicable must be taken from the river side of the embankments. The reasons for this practice, as explained to the board at that time by these engineers, and also given to me by Italian engineers for a similar rule of construction of the levees of the Po Valley, were as below, and involved no technical principles of engineering such as relates to stability or security, but are purely economical.

1. Because the land on the river side of the levee is "waste land" and of little or no value, so the material costs nothing. Borrow pits if on the river side speedily fill up from deposits at flood, and in time leave no scars, nor result in any injury to land. The slope of the Mississippi is quite small, and damage by scour is rare except in immediate vicinity of a crevasse.

2. On the land side the arable lands extended, at that time with incomplete

levees, in a narrow strip from one-fourth mile to a mile, more or less, in width.

Borrow pits, under such conditions, if on the land side, added to the width of berm left in accord with technical principles of engineering practice in earthwork construction, would destroy for cultivation from 12 to 18 acres of arable land for each mile of levee, a considerable value. Borrow pits on the land side would afterward remain as unsightly scars on the land, and whenever it rained would become stagnant mosquito-breeding pools. A planter, whenever material had to be taken from the land side of his property, very loudly and seriously objected to the injury to his lands.

In most cases levees are built to protect valuable property in the rear of them, lands, or in some cases cities and buildings, as at New Orleans, La., and Cairo, Ill., in which cases the material is taken for economy only from the river side, or is brought from a distance. On the Yuma project, the Reclamation Service then properly takes material from the river side, with levees as near the bank as may be safe to protect greatest area of land for reclamation. In Mexico, on the opposite side of the river, the same practice is not now necessary for economy. Mr. Ockerson wasted about 360 acres per mile.

If there be any other reasons than the economical ones stated above, for the rule that material for levees should be taken from the river side, I have never heard of them, and none are given by either Mr. Cory or Mr. Ockerson. It would be of great interest if they were stated and clearly explained.

If the same rules as to cut-off walls, thickness of earthwork, slopes, and berms and as to hydraulic grade lines and others affecting stability of earthen embankment dams, canal banks, etc., to enable them to sustain water pressure and guard against wave-wash and scour, be applied to levees, it would seem of absolutely no importance whatever for technical reasons, where a builder of levees gets his material, whether from the land or the river side.

WM. L. MARSHALL,
Brig. Gen. U. S. A., Retired.
Washington, D. C., Dec. 27, 1911.

[We quote the following from the valuable paper on "The Levees of the Mississippi River," by the late William Starling, published in ENGINEERING NEWS of Jan. 30, 1896:—Ed.]

All material is taken from the front or river side, if it be economically possible. The berm on the water side is usually 30 ft. The borrow pits must not be more than 3.5 ft. deep next the levee and 4.5 or 5 ft. next the river. If it be necessary to get material from the land side the pits must be distant 80 ft. or more from the inside slope-stakes.

Should Civil Engineers Organize a Union?

Sir: I have received during the past week a circular letter and two personal letters urging me to unite with certain progressive engineers and assist in organizing a union to fix rates of pay and arrange a code of ethics for engineers. Incidentally I have been asked to allow my name to be used as an officer, the hint being given that any office desired, short of president, could be railroaded toward me.

Permit me to give my reasons for not assisting in the organization of a union. They are based on my experience a number of years ago when in private practice in a large city. Real-estate development was rapid at that time and engineers were largely employed in land subdivision work. The advertising of the real-estate propositions attracted "boom chasing engineers" from every quarter of the globe, and the situation became almost intolerable because of the fierce competition.

Three well known engineers, who stood at the head of the profession in that section, called a meeting of engineers in private practice and proposed the organization of a society with a code of ethics, established minimum rates of pay, etc. The writer being very young was immensely flattered at being invited to join this organization and help on some of the committee work. He was not elected an officer, however, the offices all being given to fellows with immense reputations. It was really awfully nice to be thought worthy to join such an organization.

The code of ethics was somewhat elaborate and based on certain codes advocated by physicians and lawyers. I stood out for one sentence only as being sufficient to cover all cases, to wit, "In their dealings with professional brothers the conduct of one gentleman toward another shall be the only rule to be followed, and all men styling themselves engineers are presumed to be entitled to this distinction until found unworthy, when the duty of the engineer toward his client shall require that he present the evidence discovered."

This, however, would not do, so we had several pages of rules and regulations. One was to the effect that members bound themselves to employ only members, associate members or juniors when in need of help, and to employ no one not connected with the society when a man connected with the same could be had. Such outside help moreover was to be employed only for a period long enough to enable an application for membership to be put through. Other rules fixed the minimum percentage to be charged for work on a percentage basis, the minimum per diem charge for work and the minimum charge for surveying and subdivision work. A rule on which considerable stress was laid provided that no member should take any competitive work or knowingly give a figure for doing work on which he knew a brother member was figuring. Advertising was forbidden.

The minimum figures fixed by this code were far higher than the writer at that time had ever dared charge. They were higher than any engineers in that section could ever obtain for work, except Mr. X, Mr. Y and Mr. Z, and the men known as the "X, Y and Z crowd"; which crowd by the way held the society offices. One day Mr. X called the writer up on the telephone and informed him that he was figuring on a certain piece of work and the writer of course readily promised to keep his hands off. He felt flattered at this attention shown him and did not tell Mr. X that in all likelihood he would not have been asked to figure on it, if such big fellows were asked. In a few days other members of the "X, Y and Z crowd" also warned the writer to keep off their preserves, and in two cases he was actually invited to bid but showed the prospective clients the code of ethics and excused himself.

One day a real-estate firm for which he had done considerable work asked him to figure on a certain piece of work and he asked if others were figuring. He was told that the lowest bidder would get the work and so he had to tell the real-estate man that the rules of his society forbid him figuring. The next morning the real-estate dealer called him to his office and showed him figures received from X, Y and Z and some of their cronies. He was told that their bids were too high and if be cared to give the sort of a price he had been previously giving, the work was his. He asked for a day to consider and set out to call on the big men. They one and all informed him that they had neglected to ask if there was to be competition and seeing that they had given their figures they could not honorably withdraw them.

The writer had not thought of that simple way out of competitive work. Still he did not yet feel like breaking up the union so he turned in his figures based on the minimum charges and found that they were the same as the other fellow. In fact, these men with reputations fixed as minimum charges their regular charges, which meant that the smaller fry had to raise their figures. In such a case the man with a reputation got the work.

After that the writer gave figures also and did not ask if the work was competitive but the offices of X, Y and Z gradually filled up with men and the small fry were not getting any work. The writer was one of the small fry. To make a long story short the writer gave percentage figures on construction work and the X, Y and Z crowd gave precisely the same figures. He adopted the minimum per diem charge fixed in the schedule and

found that the same crowd went no higher than the minimum. He was hopelessly outclassed. He had to close his office and hunt for salaried jobs with the successful men. He found their offices filled with assistants not connected with the society and was told that he wanted too much pay for the kind of work the successful men were willing to give him. He called attention to the code of ethics and was informed that all the minimum charges referred to dealings with outside clients and did not govern the pay of engineers when employed by other engineers. He asked about the clause requiring assistants to become members of the society and was told that these young fellows had seemingly organized a dueless union of their own and declined to be forced into the society. As the engineers needed the assistants they had to employ them, much as they regretted being unable to employ members, etc.

The writer went out and straightway became an enemy of unions among engineers. He went back to the old rate of pay he had asked before the big fellows swelled his head. He invited competitive bids. He was willing to make deals with agents for land where he could see the other fellow's figures and cut under them provided there was a living profit in it. He furthermore wrote letters to a majority of the members telling his experience, and an interchange of confidences showed that he was not the only sufferer.

The officers declined to pay any attention to protests, and the writer, because of the inexperience of youth and his consequent folly in fighting big men, had a hard time for years afterward. Nevertheless he had the satisfaction of seeing the society break up, for no one paid dues the next year and without dues an organization cannot be kept running.

What can engineers gain by organizing unions? They lower the standing of the profession, if engineering is a profession. They cannot make rules to govern everything. Any intelligent man can be trained into a pretty good levelman in two or three months and a few weeks makes a good planetabler out of a high-school graduate. One season as a rodman, a season running a level, three months' private instruction in the winter and we have a transitman. If graduate engineers organize for higher pay in minor positions, the minor positions will cease to be filled with college-trained men. A high-school boy trained in mechanical drafting becomes a good enough draftsman for 90% of the drafting performed in engineer's offices. If college-trained men hold out for higher pay by organizing a union, we will see employers taking boys from high schools and going back to the old apprentice system.

What engineers should do is to endeavor to counteract the unwholesome advertising of certain schools which lead men to think engineering is a very highly paid profession. More than half the students now in engineering schools would take some other course if they knew all the drawbacks to the profession. Professors who take outside work at immense per diem charges and employ their graduates at starvation wages should be read out of the technical societies to which they belong on the ground of unprofessional conduct. Young graduates who advertise that "a steady job is wanted rather than good pay," should be marked men and denied admission later to any technical society. They should understand what they are doing when they consent to work too cheaply and yet they should understand that their education alone does not entitle them to big pay.

Young men should especially be warned that employment is precarious and they should make it a rule to never spend more than two-thirds their salary, no matter what that salary may be, for an engineer may confidently figure on being idle one-third of his life. Up to the age of 35 he is likely to be pretty fairly employed but after that his chances grow no better unless he has managed to save. It is the saver and not the big earner that makes the most progress. The writer wishes to endorse very heartily the editorial in ENGINEERING NEWS of Aug. 17, wherein the national societies are urged to organize employment bureaus for members of all grades. That will come pretty near being a union but it will be a proper union.

The writer was asked once to act as consulting engineer on a certain project, the promoters of which were beginning to have doubts of their engineer. He accepted the employment and told them to notify the engineer and ask if the employment was satisfactory and have him meet the writer so all matters could be gone over. This the promoters declined to do, saying they intended sending the engineer on a trip to the mountains during the week the consulting engineer was there. The writer promptly declined the work and the promoters had no trouble in securing the services of a rather eminent engineer, a really better man. The writer went to him and remonstrated and was told, "You are too careful. This engineer, so far as I know, is not a graduate and does not belong to any of the societies to which I belong, nor does he belong to any engineering societies so far as I know. I do not regard him as an engineer and feel that he is an interloper, so for the honor of the profession it is my duty to look into his work. If he has done it right then I will say so and urge him to join some of my societies. If I find him incompetent it is my duty to the profession to say so."

The writer did not quite "see" but he did feel keenly the loss of the big per diem, and for a while felt sorry that up to that time his sense of honor had not been dulled by competition. The report of course showed the engineer to have made mistakes and the big engineer was employed for a year to straighten matters out. It happened, however, that the big engineer himself made mistakes and was "fired" and the old engineer was again employed for a still bigger engineer spoke highly of his work.

Can we have unions to help the minor workers in the ranks when men grow so selfish and inconsiderate as they grow old? The first thing young graduates have to realize is that the schools are turning out more graduates than the industrial world can absorb as "engineers." Their training does fit them, however, for many kinds of work, so the majority should count it as the average man counts his college education and go to work at anything after graduation instead of hanging around the edges of the overcrowded profession and calling themselves "engineers" when they are only clerks so long as they are engaged on the minor technical operations connected with engineering work. They are not engineers for many years after graduation, and then only if their experience has been good, and they have saved enough money to go into private practice in a proper manner. Of course in speaking of engineers I do not include the men who are fixed in life positions so that they grow away from what is generally classed as engineering work. They are industrial employees.

A. B. C.

Cincinnati, O., Nov. 24, 1911.

NOTES AND QUERIES

We have received the following letter from an engineer:

Are data available from tests of rectangular reinforced-concrete slabs, supported on the long edges, and given a concentrated loading at the center? The problem might be stated as the width of such a slab, which may be considered as a beam carrying the concentrated load to the two supports. How does the percentage of reinforcement parallel with the supported edges and its position relative to the reinforcement from support to support affect the strength?

If any of our readers can furnish us this information, we would be obliged.

Corrections for Figs. 3 and 4 of the article in our issue of Dec. 21, 1911, p. 750, "Drawings for the Pattern and Core Box of a Francis Turbine Runner," by Geo. M. Peek, 34 East Grand Ave., St. Louis, Mo., are noted by the author as follows:

The horizontal tangent to the circular arc 3-3 in Fig. 4 should pass through the intersection of the line 3 with the crown in Fig. 3.

In Fig. 4, the curve 3 representing a line on the back of the bucket should terminate in the circular arc 3-3. The curve 1 on the back of the bucket was left out. The curve 1 on the front of the bucket is shown but not numbered. The finish line at the discharge edge of the bucket is left off.

In justice to the author, it should be remarked that none of these errors was present on his original drawings, and that they made their appearance in the course of preparing the cut for the illustration.

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Engineering News

Use of Weather Bureau Records by Engineers and Contractors

A source of information which may often be of great importance to engineers and contractors is the U. S. Weather Bureau, whose local offices are distributed in all parts of the country, but it is evident that the records and predictions of the Bureau are not made use of as extensively as they might be. This condition is due, probably, to a failure to recognize the practical value of the information, both in regard to records of the past and predictions as to future conditions. For example, in the execution of work upon a river; it may be of the highest importance to know the weather conditions upon the drainage area, or to be forewarned by predictions of approaching heavy rains with probable flood in the river. Again, in the construction of concrete work during the winter; warning of an impending "cold snap" may mean much to the safety of the structure.

In the report on the failure of a reinforced-concrete building at Indianapolis, in our issue of Dec. 28, reference was made to an abnormally rapid fall of temperature during the progress of the work. It was shown that general warnings of this cold wave had been sent out by the Weather Bureau, but evidently no heed was paid to them by those engaged on the construction of the building in question. On the other hand, we know of several firms which, in preparing for the construction of any concrete structure, arrange to have the Weather Bureau furnish daily records and predictions to the superintendent on the work.

Railway Construction in 1911

About 3000 miles of new railway lines were built in the United States during 1911. While this is a smaller mileage of new railway construction than that recorded in any year since 1897, it is, after all, equivalent to the construction of a railway line reaching all the way across the continent. If the average investment in these new railway lines is assumed to be $25,000 per mile, the new railway construction of 1911 represents an investment of $75,000,000.

These figures in themselves are sufficient to show that neither the railway managers nor the investing public have lost faith in the future of the railway industry, notwithstanding all that has been published regarding the effect of restrictive legislation on railway profits.

A much more important influence than restrictive legislation in reducing the amount of new railway construction is the approaching completion of the railway system in the United States. The mileage of new railways built annually in Europe has been for many years so small as to be unimportant. In the United States, also, the gridiron of railway lines east of the Mississippi is nearly complete, and in the regions west of the hundredth meridian production is too scanty and population too sparse to support a close network of railway lines.

The days of building parallel railways to divide traffic with an existing line are practically over. The only reason justifying new railway construction at the present day is the development of new territory or the extension of strong systems to reach new traffic, such as the extension of the Grand Trunk's New England lines to Providence and Boston.

All such new railway construction hereafter, however, will represent a trifling investment compared with that required for the improvement of existing railway lines. The provision of additional tracks, the reduction of grades and curves, the replacement of temporary structures with stone and concrete, the removal of grade crossings, the extension of signaling systems, the enlargement and betterment of terminals—all these will call for expenditures many times as great as the building of extensions to reach new territory.

Co-operation between Local Engineering Societies and Local Sections of National Engineering Societies

One of the stumbling blocks met by those who are endeavoring to organize local sections of the national engineering societies in various cities is the possibility of interference with the activities of the local Engineers' Club, or similar organization. There are very few cities where it will be possible to maintain a live and prosperous section of a national engineering society if it is to interfere and compete with the local Engineers' Club. That the difficulties in the situation are not unsolvable, however, is brought to our attention by the receipt of a notice of a meeting held by the "Associated Engineering Societies" of St. Louis. The notice states that these societies are the Engineers' Club of St. Louis and the local sections of the American Societies of Civil and Mechanical Engineers, of the American Institute of Electrical Engineers and of the American Society of Engineering Contractors. We commend this good example to those in other cities who are wrestling with the problem outlined above. "Behold, how good and how pleasant it is, for brethren to dwell together in unity."

It may be of interest to some of our readers to learn something of the plan under which such harmonious coöperation was secured at St. Louis. In the January *Proceedings of the American Institute of Electrical Engineers* we find the report of a conference held last summer at Chicago by the chairman of the several local sections of the institute. At that meeting, Prof. A. S. Langsdorf described the St. Louis plan as follows:

In St. Louis we were confronted at the time of the organization of the Institute section with difficulties due to the existence of the Engineers' Club of St. Louis. About a year ago it became evident to a good many of us who were interested both in the section and in the welfare of the Engineers' Club, that something would have to be done to limit the number of meetings which were scheduled, particularly in view of the fact that the members of the American Society of Mechanical Engineers had recently organized a section. Each of these organizations has interfered more or less with the others because of conflicting efforts to arrange programs.

Finally, at the instance of the president of the Engineers' Club of St. Louis, a committee made up of representatives of all the organizations got together and

drew up a scheme of coöperation which has now gone into effect and which promises very great success. The central idea of the whole plan of coöperation is to make the local club, that is, the Engineers' Club of St. Louis, the central body, in the belief that if all of the engineers of the city can be made to work in harmony, the best interests of the sections and of the national bodies themselves will be better conserved.

By the plan adopted, each branch of the national societies agreed to schedule two of its meetings each year on regular meeting days of the Engineers' Club, and to furnish the program on these occasions, the meetings to be held under the joint auspices of the particular section and the club. Secondly, each branch is free to hold as many other technical sessions per year, in addition to these two meetings, as it chooses to hold, subject only to the requirement that all of the members of the Engineers' Club shall receive notice of such meetings, and shall be free to participate in the discussion. Thirdly, the Engineers' Club, to encourage membership in the national society, as well as to advance its own interests, waives the requirement of the usual initiation fee of $10 in the case of those applicants who, at the time of their application for membership in the club, are members in any grade and in good standing of any of these national societies. Fourthly, the control of all joint meetings is in the hands of a Joint Council made up of representatives of the club and of the branches of the national societies.

Finally, the meetings and papers committee of the Engineers' Club contains representatives of the national societies, so that all the programs can be drawn up according to some harmonious plan early each year.

The Sedgwick-Letton Dual Water Supply Plan

The novel dual water-supply plan laid before the New England Water-Works Association by Prof. Wm. T. Sedgwick, of the Massachusetts Institute of Technology, and H. P. Letton, of the New Jersey State Board of Health, merits further discussion than was given it at the time the paper was presented (see ENGINEERING NEWS, Nov. 23, 1911).

There can be little, if any, question as to the sanitary feasibility of the plan. Such doubt as exists lies in the economic quarter. The duplication of a water-works system, and particularly of all the street pipes and house connections, would come nearer to doubling the cost of the present single water-works system than might appear at first thought, for though the total quantity to be provided would be substantially the same under the dual and the single systems, the cost of the denaturized supply would be materially decreased only in those elements which make for quality, and even that decrease would be partly offset by the cost of denaturizing. The cost of the pipes, house connections and meters for the potable supply would be out of all proportion to the small quantity of water delivered.

Fortunately, water purification today may be made so efficient and reliable and adds so little to the capital and operating cost of a water-supply system that in most cases it would probably be far more economical to purify to a high degree water for all purposes than to provide a dual supply on the plan proposed by Messrs. Sedgwick and Letten.

The proposal to meter the potable supply under the dual system suggests what in most cities would solve the whole problem. In other words, it is waste, not use, which makes so large a demand for water in most American cities, and if every consumer is to be metered under the dual system, why not meter every one under the present single water-supply system, and so reduce waste or increase revenue as to solve the water problem in all but highly exceptional cases?

A serious difficulty which would often arise with a dual water-supply deserves mention. In hosts of cities it is no easy task to induce householders to abandon shallow house wells, introduce city water, provide various plumbing fixtures and connect with the sewer. With a dual supply, some householders might take one and some another of the two kinds of water, but, short of compulsion, there would be many who would not take both. If only one were taken, which would be preferable, as a matter of public policy? If only the potable water were taken, water closets and bath tubs and the abolition of the privy and the polluted well would be impossible, or else the high-grade supply would be used for all household purposes. In fact, this might be the choice of all people who could afford it, rather than two sets of water piping. Should the practice extend to stores, offices, etc., the component parts of a dual system of supply would approximate each other in capacity and the underlying reasons for the dual system would lose weight. However, if the practice did not go too far, it might not greatly matter, except that once admit the principle of choice between the two water supplies and no engineer could tell how to proportion the two systems as regards the daily volume to be provided for each.

Should, then, the choice lie between connections with each supply on the one hand and no city water on the other? Or should there be no alternative at all, and the abandonment of wells and connections with the dual supply be mandatory?

Some of the foregoing opinions and speculations may seem academic, but they are scarcely more so than the paper which gives rise to them—as the authors would probably be the first to admit. In fact, it is only fair to note, in conclusion, the exact title of the original paper, which was: "Has the Time Come for Double Municipal Water Supplies: One Naturally Pure, for Drinking and Cooking; the Other Denaturized, for All Other Purposes?" The major purpose of the paper was to revive the old dual water-supply question in the light of recent and prospective progress, show a way of avoiding at least the most obvious dangers of the old-form dual supply, and bring light to bear upon the question from every viewpoint. The object was worthy and the discussion at the meeting, together with the written discussion which will doubtless appear with the paper in a forthcoming number of the *Journal of the New England Water Works Association* indicates that the object aimed at was achieved.

Commercial Designing of Concrete Buildings

It is a peculiarity of the failure of every concrete structure, where the primary fault is in the design or construction of the concrete or of its reinforcement, that a very apparent cause can soon be found, and that that cause is one which should have been apparent to anyone claiming more than an elemental knowledge of the science of building in concrete.

With a regularity almost monotonous we read of insufficient reinforcing connections, of improperly mixed concrete, of frozen material, of thin supporting struts, and of premature removal of forms, until we wonder what is the nature of men who will not learn the fundamentals of a business at which they hope to earn their living.

Various experts have from time to time issued authoritative discussions of the causes of these failures and have pointed out the few things that should not be done and the many things that should be done to secure safety of construction. Such discussions are readily available, and the principles and practices they advocate are enforced on many a well built concrete structure where he who would may see; but still a reckless disregard of safe and honest work marks too much concrete which without warrant stands to bring its builders profit and most of the concrete that fails and brings discredit to its builder and death and injury to his employees.

If it is ignorance that leads to such things, it is a criminal ignorance that should be punished equally with deliberate crime, even though the machinery of our courts and legal processes be so

cumbrous as to make such punishment difficult. But an investigation of most of the flagrant violations of the rules of safe design and construction will show that while the excuse of ignorance may possibly be made for the foreman and contractors in immediate charge of the work, the real offenders are higher up and the real cause of the trouble is a less defensible type of human frailty. Most concrete building failures are due to the parsimony of the owner or the architect who, being themselves ignorant of the principles of safe design and construction in concrete, are unwilling to spend the money to employ a competent engineer.

The usual procedure in the construction of reinforced-concrete buildings is for the owner to call in an architect to furnish the design. This architect makes a very artistic set of general drawings and then either employs an engineer to prepare the design for the concrete structure or he calls for designs from contractors. If he so far forgets his professional egotism as to call in the engineer expert, that expert not only designs a safe structure, but supervises its construction, after the contract has been awarded by the usual method.

If, on the other hand, the architect is willing to let the contractor design the structural portions of his buildings, he can usually find well established concrete contracting firms with long records of existing structures who will erect the building to conform to his general design, but under the special structural design furnished by their own engineers. The architect's functions will be those of accepting the design and of supervising its carrying out, both of which functions will be nominal, as he is technically equipped for neither.

Or, if the architect's principles rate still lower in the scale, he may allow any number of engineers masquerading as steel salesmen, or *vice versa*, to underbid each other for the privilege of furnishing him a design gratis, providing some particular system or species of steel bar is used for the reinforcement. Having secured a design by such means, he may let the contract to anyone who knows a twisted rod from an anchor-bolt and trust to Providence for a safe execution of the work.

The first of these methods is the ideal plan, which has been long tested in other branches of construction and has proved to be the plan that tends to the greatest safety combined with maximum economy. It is a solution satisfactory to all parties concerned, if all be honorable men. It does not necessarily require an independent engineer, for there are many progressive architects who have associated with them as employees or partners engineers competent to design and supervise concrete structures, or the architects themselves may be competent to perform the engineer's work. Such an engineer, either in or out of the architectural firm, does not usurp the architect's proper duties. The details of layout, decoration, trim, furnishing, etc., are all left to the expert who is qualified to supervise them; the details of concrete design and construction are likewise left to the expert who is qualified to supervise them.

Two things prevent the general acceptance of this plan, the professional jealousy of the architect and the added cost of employing an engineer. In spite of the lay impression that an architect is the proper man to construct a building, it is a fact that the important details of reinforced-concrete design and construction are far beyond the capabilities of the average architect. Rather than seek the assistance of another profession in what is popularly supposed to be his own particular field, the architect is too often willing to adopt the pernicious practice of allowing the contractor to do his own designing. Incidentally he thereby saves money for himself and his client, for an associated engineer will probably add to the cost of a contractor-designed building, though this added cost is but the necessary safeguard to life, limb and property that every honest owner should be willing to take.

There are many excellent firms who are willing to take the contractor's end of the second method above noted and to design by means of their own perfectly competent engineering force the building which they will afterward build and will finally guarantee to carry safely, under test, loads far in excess of the proposed loading. So far as technical ability goes, these contractors' engineers may be the equal of any in independent practice; and with the high ideals of a firm determined to turn out only the best work, the structures they complete may be fully equal to any supervised by the independent engineer responsible only to owner or architect. There is no monopoly of brains attached to independence in the engineering profession.

Furthermore, these firms are daily adding to their long experience in concrete construction and are, therefore, equipped for the work in which they specialize beyond the average engineer. Why, then, should not all the business be turned over to them and why should not the independent engineer and designer disappear? Mainly because such ideal firms are few and far between, but also because it is a fundamental error to have no competent technical authority to represent the owner's interests. As long as a satisfactory completed structure is the only demand made on a contractor, just so long will there be contractors who are willing to take chances in design and construction which will jeopardize property and life. Such contractors may claim that the chances of failure with their structures are practically nil; but if the general conclusion of the engineering profession is to the contrary, there must be some check upon that claim, and the only effective check is an engineer, both disinterested and competent, whose judgment is governed only by the dictates of sound engineering practice and is not liable to be warped by considerations of profit. Finally, since these firms have to provide good engineering, they will have to charge for it, so the chances are that a contract so let will not prove any cheaper than it would had an engineer been in charge of the work.

While with certain high-class firms this combination of the functions of the engineer and the contractor may prove successful, though not desirable, the very general practice of giving away designs with the steel contract is indefensible from any point of view. If only one steel company were engaged in this business, the designs which it would submit would probably err on the side of safety, for the more steel in the building, the more money in the company's treasury. But with many companies actively competing for the furnishing of the design and the steel, each engineer-salesman must reduce his cost as low as possible, knowing full well that the owner or architect who invites such competitive bidding will generally favor the lowest bidder, with little regard for other considerations.

This reduction in cost means reduction in material, and reduction in material means so close an approach to the safety limit as to make failure a matter of a slight let-up in the care used in construction and the vigilance of inspection. As the architects who are capable of allowing such practices are likewise capable of absolutely neglecting design and supervision, the natural result is collapse and maiming and death. That the proportion of failures to the number of buildings constructed in this manner is small is a testimonial to the superior qualities of concrete; it is no proof that the methods are not criminal.

At the risk of insulting the reputable word "commerce," we have called this practice "commercial designing"—"commercial," because the fundamental idea in it is the selling of material, to which integrity of design is a mere subsidiary, to be considered only if it does not interfere with the procuring of the contract. Under such conditions the design of a reinforced-concrete building becomes a matter of balancing between the cleverness of a sales-agent and the irreducible minimum of a factor of safety and loses most, if not all, of the features of an engineering process.

The cure of the evil does not lie with the engineering profession in general, for the profession is open to the charge of working for its personal advantage when it endeavors to provide a remedy. The only hope for betterment would seem to be in rigidly enforced municipal and state building regulations, designed to

prevent flimsy design from any quarter. We may also hope for a moral awakening among those owners and architects who encourage the guilty contractors, and particularly for a regeneration of those engineer-salesmen whose engineering knowledge is prostituted to the necessities of barter and sale.

There does not seem to be any good reason why the concrete-building business should not be conducted in the same manner as the building of steel structures. Why should not every architect be competent himself or have associated with him an engineer competent to design the concrete structure? Why should not this expert prepare the general structural drawings for the building upon which competent contractors may bid? Once the bid is awarded, taking into account both the competency of the bidder and the prices bid, the successful contractor could himself prepare the detail plans showing method of erection, minor steel details, etc., exactly as the steel companies now prepare shop drawings showing erection methods and connection details for the approval of the designing and supervising engineer of a structural steel building. This would remove the commercial element from design and would surely tend toward safer buildings. Such methods are very generally in use, and the buildings so erected are of the class which make the reputation of reinforced concrete as a building material.

River and Harbor Improvement

By Gen. Wm. H. Bixby *

The Corps of Engineers of the army is the organization having control of all Federal works for waterway improvement. The address of General Bixby, head of the Corps, at the National River and Harbor Congress last month is notable as a semi-official statement of the work of this organization and its attitude on such important questions as the economic depth of inland waterways, the reservoir system of river regulation and Federal control of water power development.

*Chief of Engineers, U. S. Army.

Advantage of Medium Depth in Waterways

So far as inland navigation is concerned, it is today far more important that the total mileage of rivers available to moderate-draft steamers drawing from 6 to 9 ft. should be increased than that endeavor should be made to secure a deeper-draft navigation over short sections of rivers; the deeper-draft improvement is worth its cost only near the Great Lake and ocean fronts on sections forming short extensions or connections of other equally deep natural waterways. The ideal water transportation will not be achieved until after securing such improvements of waterways as will allow the movement of boats of medium draft over all important rivers and connecting canals, and the establishment of junction boat stations and large storage yards or anchorage basins at the mouths of the busy tributaries.

Terminal Facilities and Their Control

This year, just as much as last year, one of the features most urgently requiring your careful consideration is the development of improved terminals, and their municipal control, as well as the enactment of such state and Federal legislation as will require all railroad lines to transfer to water lines, and to give through bills-of-lading and the use of all their loading and transfer facilities to any freight which shippers may desire to have consigned over lines of mixed railroad and water routes. There have been published during the past year several pamphlets of great value on the subject of terminal facilities; as those by Professor Clapp, of New York University, on the Navigable Rhine and on the Port of Hamburg, and those of the New York City Dock Commission, and of the Connecticut State River and Harbor Commission, wherein much detail is given as to the best arrangements of docks, etc. Anyone desirous of further examining into the possibilities of harbor terminal development should also consult the reports of a few years ago by the Chicago City Harbor Commission and the Montreal (Canada) Harbor Commission, such reports being on file in many large public libraries and obtainable from the City Commissions concerned. The need of today is not in all cases so much the immediate actual construction of extensive terminal facilities as the early preparation for the same, including especially the early acquisition by all water-front municipalities of wharfage fronts, sites, and surroundings, so that when the time arrives for a needed increase of terminal facilities and when people are found who are willing to put up the money for their construction, there will be plenty of free room for carrying such projects to completion, all facilities for such work shall be ready, all obstacles in the way of such work shall be removed, and when such constructions are actually built they shall be available to the general public at moderate rates and free of all monopoly.

Waterway Improvement Already in Progress

Few people realize the amount of river and harbor improvement work already adopted or under consideration by the Federal Congress. To complete the projects already favorably reported by the United States Engineer Department and already adopted by Congress will require the further appropriation and expenditure of over 200 million dollars. In addition, the Engineer Department has already recommended about 30 million dollars worth of new work which has not yet been adopted by Congress, and which is therefore as yet entirely without appropriation.

The preliminary examination and survey reports ordered by the last two River and Harbor bills will be presented to Congress at its coming session with recommendations for projects (including those for canals along the coast from New England to Texas) which will probably total about 90 million dollars' worth of new additional work, and many of these projects will probably receive favorable action by Congress. All totaled together there are, therefore, nearly 320 million dollars' worth of projects already or soon to be before the country.

Even at the rate of forty millions per year every year, it will take at least eight years of consecutive annual River and Harbor bills to complete appropriations for these projects already started or called for. During these eight years there will naturally be further demands upon the Federal Government for new examinations and new recommendations. Under such considerations it will become necessary for Congress to make an early decision as to some general outline of policy by which the completion of the work already in hand or in sight can be secured most speedily with the greatest benefit to the country at large.

It may be exceedingly difficult for Congress to draw any line between projects that have been reported worthy, upon which it can consistently stand, except perhaps one which will give to all river improvements that are clearly routes of

interstate commerce, especially those of through travel between various states, a precedence over other projects where the improvement is within the limits of a single state, or is mainly or largely of local benefit. If the United States shall establish a good standard line of water communication between all the states along the coast and through the Great Lakes and up the interstate rivers, it would seem as if it would be nothing more than fair for each individual state to assume to itself the responsibility of the extension of this general system to all connecting waterways and smaller tributaries so far as they may lie within the individual state.

In the same way, on the shore fronts of the oceans and Great Lakes and on the bank fronts of large rivers, it may be found proper or necessary to limit Federal work to the establishment of a safe anchorage and protected harbor of large area, close to and in front of the general shore line, and to require that any extension of this harbor into the interior shall be either entirely taken charge of by individual states or their municipalities, or that such states or municipalities shall make large contributions to such work as their share of the cost of the general work of transportation improvement within the state.

Storage Reservoirs, Flood Protection, Irrigation, Bank Protection, Reclamation, Drainage, Sewerage

This year, even more than last, the United States public is waking up to the necessity, or at least the desirability, of conserving all its natural resources and of so directing the improvement of each resource as to obtain the greatest benefit from all other resources connected therewith.

While the United States Engineer Department has already recognized the advantages of bank protection to save and protect property, and of levee construction and drainage to reclaim overflow lands, and of the use of water for irrigation purposes to aid farm production, and of water-power development to operate machinery for light, heat, transportation, and manufactures, it has always been obliged to consider that its own special work of river and harbor improvement was restricted to improvements for navigation until expressly otherwise authorized by Congress.

Up to today, these collateral interests have been directed mainly by the individual states; and whether a Federal control of all such related matters would be legal or even most advantageous to the country as a whole, is still subject to much doubt in Congress as well as among the general public.

As a general rule, the most important function of a river is undoubtedly its use as a free, or nearly free, route of transportation, but at the same time the river is also exceedingly useful as a means of water supply for household, municipal, factory, and farm consumption, as a means of dynamic power, and as a means of drainage and sewerage. On the other hand, the river is detrimental and often dangerous as regards its power to destroy riparian properties by erosion, and is furthermore a source of mixed benefit and danger as regards the effects from its overflow.

As a general rule, the availability of the river for irrigation and power is greatest in the upper quarter of its length, where navigation is impracticable. The river is usually most dangerous to property in the upper quarter and lower half; and its usefulness for drainage, sewerage, or refuse removal is greatest in its lower three-quarters. For direct consumption of its water by people and factories, quantity and uniformity of flow and purity of water are important features; for irrigation purposes the purity usually becomes non-essential; for power alone the quantity of water, its uniform flow, and hight of fall are important.

Droughts injure the usefulness of the river for alimentation, irrigation, drainage, and navigation purposes, and have but few, if any, redeeming qualities. Floods, though often causing great damage by bank erosion and by property destruction, are yet often of very great benefit by reason of their fertilizing deposits, which so enrich the river bottom lands that even one good crop in three years will sometimes render the land profitable to the landowner.

The special conditions most favorable to each of the above functions of a river are so divergent that it is usually impossible to establish any river improvement without detriment to one or more of such functions. A reasonable compromise in such matters is all that can be expected; and prominence must be given to the functions most valuable to the locality under consideration.

In Austria-Hungary, for example, the farming industries on the tributaries of the Danube are more important than the navigation interests, and special prominence is there given to drainage all the year, to irrigation in the dry season, and to flood protection in the wet season. On the lower Danube, between Belgrade and the Iron Gates, the navigation interests are preëminent, and the other interests are considerably sacrificed. In Germany and Belgium, the navigation interests seems to predominate; in Holland and England, all interests seem of fairly equal importance; while in France the navigation interests predominate on some rivers, and property interests on others.

In none of these countries is there any extensive and general utilization of water power on the navigable portions of rivers; the volume of water flow, combined with the river fall, being in the navigable section too small to allow of the profitable use of the water for power purposes without injury to the interests of navigation.

The same variability and conflicts of interests are found in the United States where, as a general rule, the extreme East, North and West give prominence to water power; the low grounds of the South Atlantic, Gulf and Mississippi Valley to flood protection and drainage; the high grounds of the Gulf and Mississippi Basin and the great plains to irrigation, while the navigation interests are ordinarily confined to areas not higher than 1000 feet above sea level, and occasionally to much less heights.

Under such circumstances, Federal conservation and control of water interests, as a whole, seems difficult and impracticable except within public lands; and state control within state limits, subject only to Federal control of the interests of public navigation, now seems the only immediate and, possibly, final solution of the question.

While storage reservoirs for irrigation purposes, for city and factory use, for navigable canals, or for power on the upper non-navigable portions of rivers, are used to a moderate extent throughout Europe, artificial reservoirs at river headwaters merely to prevent low-water stages in the lower navigable river are not in general or extensive use. Large lakes, like Lake Constance and Lake Geneva, are natural reservoirs and undoubtedly act to regulate the flow of their corresponding rivers; but even in such cases it is probable that the regularity of river flow is more due to the slow gradual melting of the Swiss glaciers above these lakes than to the lakes themselves. For such purposes the Great Lakes from Superior to Ontario are models of perfection, and any further regulation of the St. Lawrence basin by artificial changes in these lakes is likely to cost much more than it will be worth so far as concerns any effect upon the low-water stages.

Storage reservoirs at headwaters of rivers for merely holding back water which might otherwise produce floods are also apparently as yet of no very extensive general use in Europe. In canalized rivers each dam forms a pool which serves as a reservoir in just the place where it can produce its best and fullest effect, and the cost of additional reservoirs at headwaters would rarely be justifiable. The weakest point of an ordinary storage-reservoir system for flood prevention is that the most dangerous and injurious floods in a river basin are often produced by heavy rain-

fall in the middle areas of such basin, while the reservoirs near the headwaters of the river are too high up the river to be of use when most wanted.

The disastrous 1909 summer flood in Missouri, Kansas, and Nebraska was a good example of this, and a reservoir system at headwaters would have been sending down water just at the time when not wanted. The recent floods of the Seine above and at Paris, France, have been due largely to heavy rains over large areas where reservoirs were not practicable.

Consequently, in many European countries, such as Austria-Hungary, the protection of property from river overflow is secured usually by levees on each side of the river bank of such height and distance apart that the space between them is sufficient to hold as much water as can fall during several days of heavy rainfall in the basin above, the result of such levees being practically to form a long, narrow, temporary, and intermittent reservoir, requiring several days to fill or to empty, along the full length of the river in the place where most needed, the cost of such intermittent reservoir between levees being no more than the cost of the total of upstream reservoirs that would be necessary to produce an equally useful effect, and the bed of this intermittent reservoir between levees—that is, the occasionally overflowed lands, being useful for valuable farming or grazing purposes in the intervals between floods.

While such water control by levees is useless for irrigation or alimentation purposes, yet for reducing to a minimum the property damage from floods, it appears to have proved the most satisfactory solution up to the present time; judging from the statements of various foreign and American engineers as printed in past reports of the International Association of Navigation Congresses at European conventions and from past United States experience in the lower Mississippi River basin.

Throughout Europe, upon navigable waterways, the river banks below ordinary high-water level are usually well revetted or otherwise protected against erosion, such work being done by the general government as a part of the river improvement. Such work appears, however, to be restricted to what is necessary to secure a proper and well regulated river channel and bank, and to provide suitable locations for wharves, docks and terminal facilities, and does not appear to be extended to the mere protection of private properties unless paid for by the beneficiaries.

In many cases, especially in France, Germany and Austria, the general government and improvement associations, by condemnation or otherwise, acquire the riparian properties before commencing or completing the river improvements, by which process the reclaimed lands become sources of profit to the improvement work and help to pay therefor. This practice, so far as legal and practicable, seems worthy of being followed in the United States; and legislation in that direction should be enacted or encouraged for all locations, and especially where the local property owners do not contribute to the river improvement.

Water Power Development

The water power question has come up so prominently during the past year, that I take the liberty of urging upon you great caution in accepting any statements which have not been carefully verified, and in advocating any legislation until after much further full discussion.

Water powers are measured theoretically by a consideration of the volume of water available for use and its head or vertical distance through which it can fall during the generation of power. Practically, however, each water power is usually measured by its developed power, which is such proportion of its theoretical power as can be delivered to the middle man or to the ultimate consumer.

In order that a developed water power shall have any marketable value, there must be a demand for its use within a reasonable distance of the water fall, and the cost of delivery of the power to the ultimate consumer must not exceed the value of the use to which it can be put nor exceed the cost at which equivalent power can be produced from any other material by other processes in that locality.

In comparing valuations or rentals of water horsepowers, it is exceedingly important to distinguish between the theoretical horsepower at the crest of the dam, the horsepower when leaving the power house, and the horsepower when delivered to the consumer; as it is not at all impossible that the cost in the last case may be as much as one hundred times the cost in the first place. In some cases, water power has value when used intermittently, but in the majority of cases it is commercially useful only when its water supply, or at least its power delivery, continues practically constant and uniform.

There are cases on record where it is estimated that the original cost of the acquisition of property and of the construction of water-power development works and distribution lines has been $100 or more per horsepower, and that a rental of power to the final consumer has been as high as $75 per horsepower; while on the other hand there are cases where water is still running to waste over natural dams in large volumes, with over a hundred feet of head, because the supply of power to the ultimate consumer is already in excess of his demands and of his ability to use it.

The ownership of water powers on existing streams, while a question of great importance, is still not at all uniform throughout the various individual states and, perhaps, not yet fully settled in the courts.

Except where the Federal Government is the original owner, as within the forest reserves under charge of the Department of Agriculture, or on other public lands under charge of the Department of the Interior, or where by special acqusition and Act of Congress, as at Sault Ste. Marie, Niagara Falls, and some few special navigable streams under the Secretary of War, the Federal Government has not at present any absolute undisputed ownership of undeveloped water powers.

But on all navigable streams, and on those which affect navigation, the Federal Government has a limited control of water and water powers, exercised by the War Department. As a general rule, throughout the United States, as in England, the public right to the use of a river for purposes of navigation to the extent deemed proper by the Federal Government, takes precedence over all other rights; and the use and control of the water and of its flow within the river takes precedence over all other uses and controls. Where rivers are improved for navigation, the Federal water rights are therefore of two kinds: one that of the public right of navigation—that is, rights for everything necessary to allow free passage of boats through the river—and the other that original or acquired ownership of riparian properties, which include water and water power and rights of free access to the river at all stages, and of use of all land between high- and low-water mark when not naturally overflowed by the river.

The General Dam Act of June 23, 1910, recognized the fact that the ownership of power developed by dams constructed wholly at private expense is a matter for control by the individual states and not by the Federal Government; the Act directing that a charge be made by the Government only for such part of the total power as results from expenditures by the Government. In accordance with this Act, which must be complied with before riparian owners can build dams in navigable waters of the United States, the United States, through the War Department, is empowered to require the dam owner to furnish to the United States free of cost such water and such locks, log sluices, fish ways, and other auxiliary constructions as are necessary in the interest of navigation and the fisheries, and the Act reserves to the United States the control of water levels and a right to charge for all benefits received by the

dam owner from Government constructions. What is most essential is not so much the present development of the water power as it is such an early action by each state as shall assure the conservation of all potential water powers in such way as to prevent them from being monopolized by private parties during present disuse, and as to make possible at any future day their use to the fullest extent allowable and to the greatest benefit to the general public.

State Engineer Bureaus and State Control of Work

As levees and drainage are built principally for the reclamation of farm land and of other private properties, and as irrigation systems, including storage reservoirs together with their dams and canals, are built principally for the development of farm property and the building up of communities, such property and communities existing and being governed mainly by state laws, and as water powers are developed principally for the building up of corporations and business concerns also existing under state incorporation and ordinarily concerned mainly with other developments within a single state, it seems very proper that all these engineer constructions should be regulated, if at all, by state authority, rather than by Federal authority, and that the Federal Government should intervene only as an advisor or a controller, and should be an executive only so far as such constructions reach within the limits of several states or at least directly affect the development and prosperity of several states.

Even in the latter case it would seem most desirable that the activities of the Federal Government should not be directed to work of actual execution of the projects, but should be limited to advice and control, leaving to the local states the actual execution of all local details of construction, operation, and service, as well as the benefits connected therewith.

Because of the present growing probability that the above-named natural resources of land and water must eventually be handled in some such manner as above outlined, it is already urgently necessary that every state of the Union, which has not already done so, should establish at an early date an office of state engineer, or its equivalent, to investigate, report results, advise the state legislature, direct construction operations, and exercise state control of all work of drainage, irrigation, water-power construction, and other water utilities within each state, leaving to the Federal Government the control of only such of these constructions as concern such rivers and harbors as do not properly come under control of a single state.

Several of the states have already made great progress in such directions. For many years Massachusetts and Rhode Island have had state river and harbor commissions working always within state lines and in harmony with the Federal requirements. New York has had a state engineer directing state canals, state river improvements, and other works of public nature within the state limits. Connecticut has recently organized a river and harbor commission, which has recommended the creation of a state engineer. Illinois has organized an internal waterway improvement commission. Wisconsin and Minnesota have organized water-supply bureaus or departments to specially consider water power development and storage reservoirs, and several other states are either doing or preparing to do the same.

Now that the governors of the separate states are assembling once a year in conference to discuss all matters of common interest to the individual states, it will be far easier than in the past to not only organize state engineer officers but to operate them, under common standardized rules and regulations, agreeing so far as possible under their diverse local conditions, and, on the whole, with harmony and without conflict.

Notes from Engineering Schools

Columbia University—It has been announced that the Board of Trustees on Jan. 8 approved a plan to require a baccalaureate degree for admission to the Schools of Mines, Engineering and Chemistry. The regular courses in these schools will be covered in three years instead of four as at present. Combined collegiate and technical courses will also be arranged; these are not described beyond a statement that they will correspond to the combined collegiate and professional courses in law, medicine and teaching which are covered in six years, a baccalaureate degree being given after four.

A new department, "The School of Practical Arts," was created and placed under control of the Trustees of Teachers' College. This school will give vocational training of collegiate grade to men and women who do not desire the academic or professional training of other departments. Courses will be given in wood and metal working, art industries, sanitation and nursing, household and institutional management, design and decoration, dietetics and cooking, etc.

The Equitable Building in New York City, the home office of the Equitable Life Assurance Society, was completely destroyed by fire on the morning of Jan. 9. This building, a massive eight-story stone structure with bearing walls, I-beam floor system and hollow-tile flat-arch floors, occupied the block bounded by Broadway, Nassau, Cedar and Pine Sts., in the center of the financial district. A high wind and very low temperature combined to make fire fighting extremely difficult, but the fire was confined to the building where it started. The U. S. Subtreasury, Hanover Bank Bldg., Trinity Bldg. and other important structures, separated from the Equitable Bldg. only by the width of a street, were not damaged. The origin of the fire is not yet determined with certainty, but it is thought to have been in the kitchen of the Savarin Restaurant, in the basement of the building. At least seven men were killed in the fire.

Grade Crossing Accidents in New York State in the year 1911, according to statistics prepared by the National Highways Protective Society, killed 88 persons and seriously injured 108. In these accidents 33 automobiles, 42 wagons and four trolley cars were demolished.

In New Jersey during the same year, 43 persons were killed and 118 injured by grade-crossing accidents, while 13 automobiles, 17 wagons and six trolley cars were destroyed.

A Broken Rail is assigned in press reports as the cause of the derailment of train No. 3, the "Oregonian," on the Great Northern Ry., Dec. 30, near Sharon, N. D. Six persons were killed and some 15 others injured. Three cars were overturned, two of which rolled down a 20-ft. embankment. A fire which consumed the wreckage of two cars made it difficult to extricate the victims, but on the other hand it gave some comfort as the temperature was about 12° F. below zero.

A passenger train on the Union Pacific R.R. was wrecked 14 miles west of Laramie, Wyo., Dec. 27, by a broken rail. The locomotive and three cars left the track, and a number of passengers were injured.

The Collapse of the Porter Ave. Pumping Station of the water-works at Buffalo, N. Y., on June 30, 1911 (Engineering News, July 6, 1911, p. 30; July 13, p. 56; Aug. 31, p. 273), has been under investigation by a Supreme Court grand jury since that time. The grand jury, on Jan. 2, brought in indictments against Francis G. Ward, commissioner of public works, and Henry L. Lyon, deputy water commissioner, charging manslaughter in the second degree in connection with the death of the eight workmen who were killed in the collapse. The same jury brought in a verdict of "no bill" against George Worth, the contractor for the steel work, and Robert A. Wallace, the architect, who were separately charged with manslaughter in the second degree.

Sewage Treatment by Contract at Columbus, Ohio, is thus noted in the annual report (for 1910, just published) of Walter W. Jackson, Engineer in Charge of the Division of Sewage Disposal of the Department of Public Service of the city named:

> Arrangements have been completed for the treatment of the sanitary wastes from the Buckeye Steel Castings Co., not to exceed 80,000 gal. per day, for the sum of $630 annually, the sewage reaching the city's system through the old Keever Starch Co.'s line, and for the handling and treatment of sanitary wastes from the village of Grandview Heights, delivered into the intercepting sewer at Goodale St., for the annual payment of 75c. per capita. These figures are based on the cost of operation of the pumping station and purification works plus fixed charges on the plant, and are more equitable than prices made in the past for connections to the city's system.

Improvements to the Water-Works of New Brunswick, N. J., have been recommended to the city council by an advisory committee of six, including Drury W. Cooper, as president, and Alfred A.

Titsworth. The committee advises that the present supply from Lawrence Brook be continued; that Milltown be persuaded or compelled to remove its sewage from the brook by building a disposal plant outside the drainage area; that the storage capacity of the present reservoir be increased by a slight raising of the dam; and that the water be purified, either by filtration alone, or by rapid filtration and ozone treatment, should the latter prove to be practicable. In case Milltown will not remove its sewage, then a new storage reservoir (evidently above the source of pollution) is advised, with a supply main from the reservoir to the present pumping station.

A Street Car Fell from a Bridge at Cincinnati, Ohio, Jan 5, after being derailed at a sharp curve in the tracks on the approach to the bridge. The accident occurred on the Central Bridge, which connects Cincinnati with Newport, Ky. The car fell 55 ft., according to press reports, landing in Front St., Cincinnati. Of the five persons on board, four were reported fatally injured and the fifth was seriously hurt.

A trolley car carrying 35 persons fell from the Black Bridge, between Pottsville, Penn., and Schuylkill Haven, Dec. 25, dropping 20 ft. into the Schuylkill River. The water in the river at this point was only about 6 ft. deep, and reports state that none of the passengers was injured. The accident is ascribed to a broken rail.

Twenty-Nine Towns in Ontario on Jan. 1 voted to construct municipal electric distribution lines and to take power from the Niagara Falls transmission system of the provincial Hydro-Electric Commission (which is to become the provincial Department of Hydro-Electric Power). In no case where the proposition was voted on was the project rejected. Toronto voted to issue bonds for $2,200,000 for extending and completing the municipal distribution lines.

New Locomotive Boiler Inspection rules for all railways under the jurisdiction of the Railway Commission of Canada, went into effect, Jan. 1. The following summary of the conditions imposed by the new rules is taken from the Toronto "Globe":

A safe working pressure is to be fixed by the chief mechanical officer of the company, or a competent mechanical engineer under his supervision. The mechanical officer in charge at each point where boiler work is done is to be held responsible for the inspection and repair of all locomotive boilers. Not less seldom than once each month, or within 15 days after inspection, a report is to be filed with the chief operating officer of the board for each locomotive used.

In case of accident from failure of a boiler or appurtenances resulting in serious injury or death the carrier owning or operating the locomotive is required immediately to wire the particulars to the operating officer regarding the accident, giving the complete list of killed and injured. A penalty of $100 is provided for the contravention of any of the clauses of the new regulations.

Acquittal in the Harris & Blanck Fire case. A trial jury has acquitted Isaac Harris and Max Blanck of charges of culpable negligence in connection with the fire horror in their "Triangle Shirt Waist" factory, in New York City, Mar. 25, 1911 (Eng. News, Mar. 30, 1911, p. 396). About 150 girls and men were killed in that fire—by burning, by jumping from the windows of the eighth, ninth and tenth floors when no other path of escape was left, or by falling down the elevator shaft. There were two exit doors at each floor, but the employees were restricted to the use of one. Many witnesses testified that the other door was kept locked; others testified that it was open whenever they had tried it. The essential charge was that the proprietors of the factory had kept this door locked and thereby contributed to the holocaust. It was testified that the floors were filled with close-set rows of sewing machines, in an arrangement which hampered rapid access to the doors; that the floor was covered with a large amount of cloth cuttings; that the door opened inward; that a railing around the door limited access to it; that it was the custom to examine all employees before leaving work at night to make sure that none carried away any goods; and that while all were familiar with the employees' exit (on the Greene St. side), few were familiar with the Washington Place exit. The judge charged the jury that to find the defendants guilty they must find that the Washington Place door on the ninth floor was locked at the time of the fire, and that Harris and Blanck had personal knowledge that it was locked. The jury acquitted largely because of the latter part of the charge.

A New Cuyahoga River Bridge in Cleveland is soon to be built, after agitation extending over a number of years, with a view to bettering conditions highly unfavorable to the full development of the city. Unfortunately, the project now under way is not adapted to place the matter on a finally satisfactory basis. The central part of Cleveland is connected with the territory west of the Cuyahoga River by two bridges containing draws; one at Superior St., called the Superior Viaduct, which reaches the center of the city, and the other about 1¼ miles south, called the Central Viaduct. Neither of these bridges affords the most direct route for street or trolley-car traffic, and, moreover, their capacity is inadequate for the traffic requirements. The Superior Viaduct, the more important of the two, has long been recognized to be too weak for the service, and being a low-level structure its approach grades were objectionable. Two or three years ago a start was made toward reaching the proper solution, by the appointment of an engineering committee by the then Mayor Thos. L. Johnson. This was known as the High-Level Bridge Commission. Mayor Johnson's successor, Mayor Baehr, continued this commission in office. Although study of the traffic situation was made and the existing bridges were examined, real-estate questions, river traffic and all other factors affecting the question were investigated in the course of the inquiry. The weakness of the Superior Viaduct was brought to light early and the commission recommended certain changes and repairs to render it safe. These recommendations were followed. It was also recommended that the Central Viaduct be converted into a high-level bridge without a draw, which is now being carried out. The study for the purpose of determining the proper location for an additional bridge resulted in choosing a location about halfway between the Superior and Central Viaducts. A high-level bridge was recommended for this location, requiring no draw. The plan was to build the new crossing, divert traffic to it from the Superior Viaduct and then rebuild the latter either on the same location or on a location nearby, making it a high-level structure. Before the work of the commission was quite complete, however, legal difficulties entered the problem by the action of the County Commissioners, who claimed that they and not the city were the proper authorities to build a new bridge. Their position was sustained by the courts, to the extent at least of recognizing their authority to build a bridge on a county road, which would give them the power to rebuild the Superior Viaduct or erect a structure near it, but would not permit their constructing the recommended new bridge between the two existing bridges, as there is no county road at that location. On the other hand, the city was unable to proceed with the plans for the intermediate bridge because its proposals to the people for bond issues were defeated, being unable to obtain the required two-thirds majority, whereas the County Commissioners under the law required only a plurality vote and, therefore, succeeded in obtaining authorization to issue bonds. The result of these conditions is that the County Commissioners are in a position to proceed with rebuilding the Superior Viaduct and have drawn plans for the work. It is expected that the construction will soon begin. The city, however, is not in a position to carry out its project for an intermediate bridge, and this desirable improvement is compelled to wait for another time.

One result of the complications which surrounded this case has been that the law governing the issuance of bonds by the County Commissioners has been changed by the legislature. Hitherto the procedure was to obtain authorization from the people in an election for the issuance of bonds and, upon a favorable vote, the commissioners were authorized to issue bonds for any amount they might fix, limited, of course, to the particular purpose specified in the election. The amended law requires the commissioners to state in advance what amount of bonds is to be issued, the approval by the election being only for this specified amount.

Personals

Mr. Wm. L. Brown, of San Bernardino, Calif., has been appointed City Engineer of Rialto, Calif.

Mr. J. A. Gibson, Division Master Mechanic of the Peoria & Eastern Ry., at Urbana, Ill., has resigned.

Mr. George W. West, of Dessery & West, Engineers, Union Trust Bldg., Los Angeles, Calif., has been appointed City Engineer of Glendora, Calif.

Mr. Clifford M. King, Assoc. M. Am. Soc. C. E., has resigned his office of City Engineer, of Sandusky, Ohio, to enter private practice in the same city.

Messrs. R. F. Stoddard, Assoc. M. Am. Soc. C. E., and M. F. McKenna, formerly City Engineer of Bridgeport, Conn., have opened an office at 88 Fairfield Ave., Bridgeport, for the practice of civil engineering.

Mr. Thomas W. Orbison has resigned as Vice-President of the O'Keefe-Orbison Engineering & Construction Co., of Appleton, Wis., to enter private practice as a consulting engineer with offices in Appleton.

Mr. R. W. Edwards, Superintendent of Terminals, of the Kansas City Southern Ry., at Kansas City, Mo., has resigned to accept a similar position with the Pittsburgh & Lake Erie R.R., at Youngstown, Ohio.

Mr. George J. Henry, Jr., M. Am. Soc. C. E., has resigned as Chief Engineer of the Pelton Water Wheel Co., of San Francisco, Calif., in order to enter private practice as a hydraulic and mechanical engineer.

Messrs. Dwight P. Robinson, M. Am. Inst. E. E., President and General Manager of the Stone & Webster Engineering Corporation, and John W. Hallowell have become partners of the firm of Stone & Webster, Boston, Mass.

Mr. Howard C. Baird, M. Am. Soc. C. E., formerly Principal Assistant Engineer with Boller & Hodge, 149 Broadway, New York City, has been made a member of the firm, which will hereafter be known as Boller, Hodge & Baird, Consulting Engineers.

Mr. Walter J. Jones, Assoc. Am. Inst. E. E., a consulting engineer of New York City, has been selected by the Montreal Electric Service Commission, Montreal, Que., to take charge of the underground electric conduit construction to be installed in that city.

Mr. S. D. Sprong, M. Am. Inst. E. E., has resigned as Chief Electrical Engineer of J. G. White & Co., Inc., New York City, to become Electrical Engineer of the Brooklyn Edison Co., of Brooklyn, N. Y. He will retain his connection with J. G. White & Co., Inc., as Consulting Electrical Engineer.

Mr. Francis M. Lawler, Master Mechanic of the Cleveland, Cincinnati, Chicago & St. Louis Ry., at Brightwood, Ind., has retired on a pension after 41 years' service with this railway, 22 years of which he has been a master mechanic. He is succeeded by Mr. F. K. Murphy, Superintendent of Air Brake Equipment.

Dr. Rupert Blue has been appointed Surgeon General of the United States Public Health and Marine Hospital Service, to succeed Walter Wyman, deceased. Dr. Blue has been with the Service since 1892, and is well known for his investigations in connection with the causes and prevention of bubonic plague and yellow fever.

Mr. Benjamin E. Bush, President of the Missouri Pacific Ry., has been elected President of the Denver & Rio Grande R.R. also. Mr. Bush succeeds Mr. E. T. Jeffery, who has been President since 1895. Mr. Jeffrey has been made Chairman of the Board of Directors, succeeding Mr. George J. Gould, and will have charge of the finances of the company.

Mr. Thomas Rumney, General Mechanical Superintendent of the Erie R.R., has resigned and will become General Superintendent of Motive Power of the Chicago, Rock Island & Pacific Ry., at Chicago, Ill., succeeding Mr. W. A. Nettleton, resigned. Mr. Rumney is succeeded as General Mechanical Superintendent of the Erie R.R. by Mr. William Schlafge, Mechanical Superintendent at Jersey City, N. J.

Mr. J. W. Higgins, Assistant General Manager of the Missouri Pacific Ry., has been promoted to General Manager, succeeding Mr. A. W. Sullivan, resigned. Mr. Higgins began his railway service at the age of 15 years as a messenger boy with the Illinois Central R.R. In the last 30 years he has occupied nearly every position in the operating departments of various railways, rising from track laborer to his present office.

Mr. W. G. Chace, M. Am. Inst. E. E., of Smith, Kerry & Chace, Engineers, Toronto, Ont., has removed his headquarters from Winnipeg, Man., where for the past five years the firm has had charge of the construction of the municipal hydroelectric plant, to Portland, Ore., where he will have charge of the completion of the works of the Mount Hood Railway & Power Co. The office in Winnipeg will be closed and an office at 608 Lewis Bldg., Portland, opened.

Mr. O. L. Dickeson, formerly with the Chicago, Burlington & Quincy R.R., and recently Vice-President of the White Pass & Yukon Route, at Vancouver, B. C., has been made President of the latter company. Mr. Dickeson is 34 years old, and is said to be one of the youngest railway presidents. The White Pass & Yukon Route includes the following: Pacific & Arctic Ry. & Nav. Co., British Columbia Yukon Ry. Co., British Yukon Ry. Co., and the British Yukon Navigation Co., Ltd.

Mr. T. E. Clarke, formerly General Superintendent of the Delaware, Lackawanna & Western R.R., has been appointed Assistant to President Truesdale, of the same railway. Mr. Clarke will attend to the executive matters of the western part of the railway and will continue to keep his headquarters at Scranton, Penn. In 1900, Mr. Clarke was General Manager of the Iowa Central Ry.; the same year he went to the Delaware, Lackawanna & Western R.R. as Division Superintendent, becoming General Superintendent in less than a month. Mr. E. M. Rine, Assistant General Superintendent, has been promoted to General Superintendent, succeeding Mr. Clarke, and the position of Assistant General Superintendent has been abolished.

Mr. Howard D. Taylor, Superintendent of Motive Power and Rolling Equipment of the Philadelphia & Reading Ry., and its numerous subsidiary lines, has resigned. Mr. Taylor was for ten years, from 1882 to 1892, with various locomotive works; in 1892 he became Engineer of Tests of the Erie R.R. Two years later he accepted a similar position with the Lehigh Valley R.R., later becoming Mechanical Engineer and Master Mechanic of the same railway. After two years as Assistant Superintendent of Motive Power of the Calumet & Hecla Mining Co., he returned to the Lehigh Valley R.R., in 1901, as Superintendent of Motive Power. In 1904, he accepted a similar position with the Philadelphia & Reading Ry. Mr. S. G. Thomson, Assistant Engineer of Motive Power, has been appointed Acting Superintendent of Motive Power and Rolling Equipment, succeeding Mr. Taylor. Mr. Thomson is a graduate of Princeton University, class of 1898, and received his railway training with the Pennsylvania R.R.

Mr. Caleb Mills Saville, M. Am. Soc. C. E., has resigned his position with the Isthmian Canal Commission, where he was in charge of the Third Division of the Office of the Chief Engineer, to accept an appointment as Chief Engineer in Charge of the Water-Works of the City of Hartford, Conn. Mr. Saville's work includes the construction of an additional water supply, which will be taken from Nepaug and Phelps Brook sources. Included in this work will be the construction of three reservoirs, with dams and curtain walls, and a masonry dam something over 100 ft. in height, about eight miles of 42-in. conduit, a pressure tunnel about a half mile long, and ultimately the construction of filtration works for treating the entire supply of the city. Previous to undertaking his Panama Canal work, Mr. Saville was for ten years Division Engineer on the Metropolitan Water-Works, of Boston, Mass. For the past four years he has been with the Isthmian Canal Commission. His most conspicuous work there has been the investigations for the foundations and methods of building the Gatun dam and he was in charge of the construction of this work previous to taking charge of a division in the Chief Engineer's Office.

Obituary

Charles H. Ramsey, General Sales Agent of the Helderberg Cement Co., of Albany, N. Y., died on Dec. 25, 1911.

Frank N. Gibbs, M. Can. Soc. C. E., died in London, England, on Dec. 30, 1911. He was a son of Mr. Frederick Gibbs, of Fort William, Ont., and a graduate of the Kingston Royal Military College.

Haines Lloyd Hart, a graduate in mechanical engineering of Cornell University, class 1907, died at the New Rochelle (N. Y.) Hospital on Jan. 4. He was 27 years old and employed by the Westchester Lighting Co. He was a native of Auburn, N. Y., and leaves two sisters.

Joshua Binion, a civil engineer and former resident of New York City, died in Johannesburg, South Africa, on Nov. 27. He was a graduate of Columbia University School of Mines, class of 1898, and was for a time employed in the engineering department of the Central R.R. of New Jersey. Later he was employed in the work of planning the New York Subway system. Of late years he had been practicing his profession in South Africa, where he originally went in search of health.

William Billings Clapp, District Engineer of the United States Geological Survey, California district, died at his home in Pasadena, Calif., on Dec. 26, 1911. He was born at Conway, Mass., Apr. 11, 1861, and received a high-school education, supplemented by special studies. His earliest engineering work was in the subdivision of public lands in northern California in 1882. Later he assisted in the construction of some cable railways and was Assistant Engineer of the Los Angeles & Salt Lake Ry. In 1889 he was engaged in private practice in Seattle, Wash., and two years later was again in California as Engineer and Roadmaster of the San Gabriel Valley Rapid Transit Co. The following two years he was Chief Engineer of the Arizona Waterworks and Sewerage Co., and in private practice in Pasadena, Calif. In 1894 he was chosen City Engineer of Pasadena and held this office until 1901, when he again engaged in private practice and in special work for the United States Geological Survey. In 1903 he was an assistant engineer in the U. S. Reclamation Service, and since 1904 had had charge of the water resources investigations of California for the Geological Survey. He is survived by a widow.

Richard T. Crane, President of the Crane Co., of Chicago, Ill., a millionaire manufacturer well known to engineers by his numerous attacks upon colleges and college men, died on Jan. 8. He was born in Paterson, N. J., in 1832, and had

very few advantages in the way of education. He learned the machinist trade in Paterson, Brooklyn and New York. In 1855 he removed to Chicago, Ill., where an uncle helped him to start a brass foundry. In this project he was soon joined by his brother Charles S. Crane, and under the firm name of R. T. Crane & Bro., began the manufacture of heating apparatus in 1858. The business prospered and in a few years, after a number of changes in name, the Crane Co. was among the largest manufacturers of valves and pipe fittings in this country. In 1867 he also started the manufacture of elevators and founded the Crane Elevator Co., of which he was President. Mr. Crane had become conspicuous during the later years of his life for his views on college and technical education, and his views on these subjects are familiar to readers of Engineering News. The same page of a metropolitan daily newspaper, which contains a notice of his death, also contains a bitter attack by him on universities in general and the University of Illinois in particular. He is reported as having said:

The further I go into this education question, the more firmly am I convinced that I was right when I took the ground some years ago that this university, as well as all others, ought to be burned down and that the money spent on them should be expended where it would do some good.

Engineering Societies

COMING MEETINGS

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 16. Annual meeting at Pittsburg, Penn. Secy., Elmer K. Hiles, 3511 Oliver Bldg., Pittsburg, Penn.

WOOD PRESERVERS' ASSOCIATION.
Jan. 16-18. Annual convention at Chicago, Ill. Secy., F. J. Angier, Mount Royal Station, Baltimore, Md.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at New York City. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 17-19. Annual meeting at Urbana, Ill. Secy., E. E. R. Tratman, 1138 Monadnock Block, Chicago, Ill.

SOCIETY OF AUTOMOBILE ENGINEERS.
Jan. 18-20. Annual meeting at New York City. Secy., Coker F. Clarkson, 1451 Broadway, New York City.

KANSAS ENGINEERING SOCIETY.
Jan. 23-24. Annual meeting at Manhattan, Kan. Secy., W. S. Gearhart, Manhattan, Kan.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 23-25. Annual meeting at New York City. Secy., W. W. Macon, 29 West 39th St., New York City.

OHIO ENGINEERING SOCIETY.
Jan. 24-26. Annual meeting at Cleveland, Ohio. Secy., Clyde J. Knisely, New Philadelphia, Ohio.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 24-26. Annual meeting at Montreal, Que. Secy., C. H. McLeod, 413 Dorchester St., West Montreal, Que.

INDIANA ENGINEERING SOCIETY.
Jan. 25-27. Annual meeting at Indianapolis, Ind. Secy., Charles Brossman, Union Trust Bldg., Indianapolis, Ind.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
Feb. 14-15. Annual meeting at Boston, Mass. Secy., N. W. Gifford, 26 Central Square, East Boston, Mass.

IOWA ENGINEERING SOCIETY.
Feb. 21-23. Annual meeting at Davenport, Iowa. Secy., S. M. Woodward, Iowa City, Iowa.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Mar. 6-9. Annual convention at Chicago, Ill. Secy., T. A. Randall, Indianapolis, Ind.

Municipal Engineers of the City of New York

The ninth annual dinner was held Jan. 6, at the Hotel Savoy, in New York City.

Brooklyn Engineers Club

The amount of the Alfred T. White prize for the most valuable paper presented during each year was erroneously given in our issue of Jan. 4 as $15. The amount of the prize is really $50 in cash.

Cleveland Engineering Society

At the regular meeting of Jan. 9, Mr. C. E. Denney, Signal Engineer of the Lake Shore & Michigan Southern R.R., presented a paper entitled "Railway Signaling." At a special meeting to be held Jan. 23, Mr. R. C. Beardsley will present a paper on "Design and Construction of Dams," in which he will give special reference to recent dam failures.

American Institute of Consulting Engineers

Nominees for members of the council, to be elected at the annual meeting in New York City, Jan. 16, have been chosen by the nominating committee as follows: Geo. F. Swain, Cambridge, Mass., to serve till January, 1913; and Alfred Noble, New York, Edward C. Shankland, Chicago, and Frank J. Sprague, New York, to serve till January, 1915.

American Institute of Mining Engineers

The January meeting of the New York section was held at the Engineering Societies Building, New York City, Jan. 5, 1912. Dr. Gardner F. Williams, of Washington, D. C., gave an illustrated lecture on "The South African Diamond Fields." At the February meeting, which will be held Feb. 13 and will be a joint meeting with the American Society of Mechanical Engineers, Mr. Robert D. Cranston will give a talk on "The Design and the Mechanical Features of the California Gold Dredge."

American Society of Civil Engineers

Mr. H. G. Stott, of New York City, has resigned his position as a director of this society and Mr. Charles W. Stamford, Chief Engineer of the Department of Docks and Ferries, of New York City, has been elected to succeed him.

The annual meeting of the San Francisco Association of members of this society was held at the Palace Hotel, Dec. 15, in San Francisco, Calif., with an attendance of 75 members and guests. The secretary's report stated that the average attendance during the past year has been 67, as compared with 42 during the preceding year. The net increase in membership for the year was 28, making the present membership 146. The treasurer's report showed a balance on hand of $2682. Officers for the ensuing year were elected as follows: President, C. E. Grunsky; vice-president, C. H. Snyder; secretary, E. T. Thurston.

Society of Automobile Engineers

Nominations for officers to be elected at the annual meeting in New York City, Jan. 18-20, have been made by the nominating committee as follows: For President, Henry F. Donaldson; for vice-president, H. W. Alden and Harold L. Pope; for Treasurer, Hermann F. Cuntz. During the automobile show at Madison Square Garden, the Society will exhibit numerous examples of the standards established for materials and details of construction of automobiles. The annual dinner will be held at the Hotel Astor, Jan. 19.

At a meeting of the Metropolitan section, held Dec. 28, in New York City, Mr. P. S. Tice presented a paper dealing with the desirable number of gear changes in a gasoline car. At a special meeting of the section to be held in the Engineering Societies Building, New York City, Jan. 12, Mr. Charles Y. Knight, the inventor of the Knight sleeve-valve engine, will give an address on "The Evolution of the Slide-Valve Internal-Combustion Engine."

American Public Health Association

The sanitary engineering section, which was authorized at the recent annual meeting of this association at Havana (December, 1911), will meet for organization at the house of the American Society of Civil Engineers, 220 West 57th Street, at 12 o'clock, noon, of Friday, Jan. 19. This date has been chosen for the convenience of those who are members of both associations. Members of the American Public Health Association will be eligible for membership in the sanitary-engineering section of that association, without the payment of further dues. We understand that some thirty engineers, more or less, are already members of the American Public Health Association. Provision was made at the Havana meeting for the election of members to the association between the annual meetings, thus making it possible, we presume, for engineers who are not already members of the American Public Health Association to become such at once and take part in the sanitary-engineering section. Mr. J. L. Ludlow, Winston-Salem, N. C., is chairman of the committee on organization of the sanitary section named. Dr. W. C. Woodward, Health Officer of Washington, D. C., is Secretary of the American Public Health Association.

Wood Preservers' Association

The program of papers to be presented at the eighth annual convention, to be held in the Hotel Sherman, in Chicago, Ill., Jan. 16-18, is as follows: "The Scientific Management of Timber Preserving Plants," C. Burkhalter; "The Production of Wooden Cross-Ties," A. R. Joyce; "Preservation of Power Transmission Poles," H. R. Wheaton; "Inspectors and Inspection at Commercial Plants," R. L. Allardyce; "The Structure of Commercial Woods in Relation to Their Treatment with Preservatives," Howard F. Weiss; "The Effect of Fire on Creosoted Material," R. J. Calder; "Creosote and Creosoting Oils," David Allerton; "Economic Materials for Boat and Barge Construction," A. E. Hageboeck; "Creosote Oils, Specifications and Analysis," F. R. Church; "Treating Seasoned vs. Unseasoned Ties," F. J. Angier; "Efficiency in Plant Operation," T. A. Sterling; "Evaporation of Creosote and Crude Oil," T. E. Fredondoll; "Yard Arrangement and Piling Systems," J. H. Waterman; "Wood Block Pavement from a Construction Standpoint," D. R. Okes; "Cutting and Seasoning Timbers," A. Meyer; "Creosote Specifications and Analysis," Hermann von Schrenk; "Creosoted Wood Paving Block," A. E. Larkin; "Comparison of the Absorptive and Extensive Properties of Creosoted Wood Paving Blocks Treated with Crude Road Oil and with Ordinary Creosote Oil," H. M. Rollins.